SOUND HANDBOOK 2000

Hints and advices for car sound builders using DLS / GENESIS amplifiers and DLS speakers

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INTRODUCTION

We have made this handbook as a small help for thoose who want to do a first class car sound installation.
This book advices the reader in matters concerning amplifier and speaker installation and wiring, passive crossovers, cable choice and different bass box constructions. Information about DLS products can also be found on our Internet WEB-site www.dls.se

DLS SOUND PHILOSOPHY

DLS sound philosophy is based upon providing equipment that will accurately and faithfully reproduce all kinds of music without distortion and colouration. The sound reproduction must be natural, the soundstage well imaged and stable even when the tweeters are mounted apart from the bass/midrange elements.
If you close your eyes the sound should be as close as possible to the real. You should be able to experience the sound as it is in the concert hall or on a rock concert. Every instrument and singer should be on it´s correct place on the stage. To achieve this you need a good front stage image and to do such an installation is not easy. DLS or GENESIS amplifiers and DLS speaker systems will help you to achive a sound as good as possible, but you also have to do a correct installation if you want a perfect result. This book will give you hints about doing a good installation.
DLS lay a great job in developing and refining the different products in order to give the market the best Car-Hi-Fi products possible to the worlds most demanding listeners.

DLS AMPLIFIER PHILOSOPHY

A wellknown french sound philosopher, Jean Hiraga, said regarding home Hi-Fi: A good sound starts in the mains plug and then through the AC/DC-converter, which must be oversized.
The same is valid for Car Hi-Fi, the amplifier must at all occasions have enough power to make a good job. Remember to use well oversized cables from the battery to the amplifier. It is also essential that the DC/DC-converter is well oversized to make it distribute enough power to the amplifiers final stage when it´s needed, otherwise both the dynamics and the good sound will be lost. The amplifier will sound "tired" and the sound will be strained. The bass will lack the real "bass-kick" and the treble becomes sharp instead of soft and airy.
The built-in amplifers in most CD:s and stereo casette players can´t stand up to these demands. To achieve a good sound it´s necessary to install. an external high quality amplifier.

AMPLIFIER CLASSES

Depending upon the construction, amplifiers are divided into different classes, there are class A, AB, B or C. The characteristic mark for a class A amplifier is the lack of switching noise distortion, which the other types have. The class A amplifier also has a higher idle current, but instead it creates a much better resoulution and dynamics. For home use the class A amplifiers are not very common, many people think they are only for sound connoisseurs and Hi-Fi entusiasts. Powers from 2x15 up to 2x50 Watts are common on these types, no high power, but instead real good AC/DC-converters with reliable power resources.
The most common amplifier type is class AB.

CLASS A - IN A NEW WAY

To make a pure class A amplifier for in-car use would be relatively easy, but would cause many problems. the main problem is the efficiency of true class A operation. To provide 50 watts per channel would require a power consumption of about 250 watts continuous. This is around 21 A from a 12 V system. A second battery and maybee alternator would be required for most installations. This would also require fan cooling to get rid of the heat.

In a class "A" amplifier, the improvement in sound quality is thanks to absence of switching noise from the output transistors. The penalty for this is that the amplifier is not efficient and wastes energy. By using a special biasing circuit to ensure the output transistors do not switch off, the GENESIS amplifiers achieve all the advantages of a class "A" operation with only a small reduction in efficiency.
All amplifiers can be used in bridgemode and multi-mode applications.

The new GENESIS series 3 amplifiers can not be defined either as class A or AB. They are a unique GENESIS construction. All amplifiers are 2 Ω stable except for Monoblock and the subwoofer channel on Five Channel which are 1 Ω stable.

GENESIS AMPLIFIERS TO 97-10.

SA-30	class "A"	B-40	class "AB"
SA-50	"	SM-60	"
DA-100	"	SM-100	"
Q-100X	"	DM-200	"
P-300X	" + AB	Q-200X	"
MONO-250	"		

GENESIS AMPLIFIERS FROM 97-11.

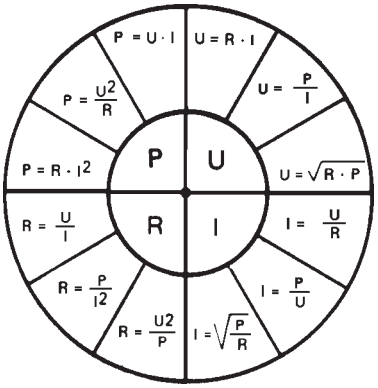
Stereo 60	Stereo 100
Dual Mono	Four Channel
Five Channel	Monoblock

DLS amplifiers Reference-100 and reference 200 uses class "AB" operation.

FORMULAS

It´s easier to understand some parts in this book if you know some of the formulas on this page. They are also useful at many other occasions.

OHMS LAW:
R = resistance in ohm, U = voltage in Volt
I = current in Ampere, P = power in Watt



GEOMETHRY:

Circel:
r = radius O = periphery
d= diameter A = area

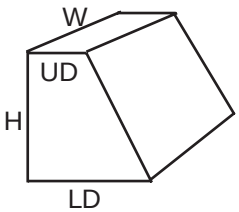
Radius (r) = $\frac{O}{2\pi}$ Diameter (d) = $\frac{O}{\pi}$

Periphery (O) = $2\pi \times r$ Area (A) = $\pi \times r^2$

Box volumes (V):
When caculating the volume of a box you simply multiply the width (W) x heigth (H) x depth (D). Use measures in dm and you will get the answer in liters.
A trapezoid box is calulated as below:

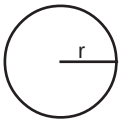
V = width (W) x heigth (H) x $\frac{\text{upper depth + lower depth}}{2}$

To get the net volume use the inner measures of the box.



Volume (V) of a pipe:
D = depth (length) r = radius

$V = r^2 \times 3{,}14 \times D$



Use measures in dm and you will get the answer in liters.

MEASURE CONVERSION

The following relation between some units are useful to know of.

1 yard (yd) = 3 ft = 36 in = 0,9144 m
1 foot (ft) = 0,3048 m
1 inch (in) = 2,54 cm
1 square yard (yd^2) = 9 ft^2 = 1296 in^2 = 0,8361 m^2
1 square foot (ft^2) = 144 in^2 = 9,290 dm^2
1 square inch (in^2) = 6,452 cm^2
1 cubic yard (yd^3) = 27 ft^3 = 0,7646 m^3
1 cubic foot (ft^3) = 1728 in^3 = 28,32 dm^3
1 cubic inch (in^3) = 16,39 cm^3
1 pound (lb) = 16 oz = 0,4536 kg
1 ounce (oz) = 28,35 gram

CONVERSION GAUGE - mm^2

Gauge (ga) is an American measure for cable areas, also called AWG (American Wire Gauge).

1 AWG = 42 mm^2	9 AWG = 6,8 mm^2
2 AWG = 33 mm^2	10 AWG = 5,3 mm^2
3 AWG = 27 mm^2	11 AWG = 4,2 mm^2
4 AWG = 21 mm^2	12 AWG = 3 mm^2
5 AWG = 16 mm^2	13 AWG = 2,7 mm^2
6 AWG = 13 mm^2	14 AWG = 2 mm^2
7 AWG = 10 mm^2	15 AWG = 1,65 mm^2
8 AWG = 8 mm^2	16 AWG = 1,3 mm^2

SPEAKER TERMS

It´s useful to know what the most common speaker data terms stands for.
Fs = speaker resonant frequency in Hz
Fc = box resonant frequency in Hz
F3 = approximative lower frequency for vented boxes in Hz. Often called F-3 dB point = the point where the power is half.
Qes = the speakers electrical Q-value
Qms = the speakers mechanical Q-value
Qts = the speakers total Q-value
Vas = Eqvivalent air volume. The air volume having the same aqoustic compliance as the speaker suspension.
X-max = voice coil length - 2 x thickness of the inner pole plate.
Sd = the speakers effective cone area
Vb = net volyme of the box
SPL = sound pressure level in dB
Sens. = speaker sensitivity in dB at 1Watt / 1 mtr
Re = speaker DC resistance in ohms
Mms (Mmd) = moving mass
Le (Lbm) = Voice coil inductance
RMS = AC mean power
BL = The factor of theflux density in the magnetic gap in the speaker x the wire length of the voice coil

DECIBEL - dB

dB is a unit used to describe a realation. It´s used to describe an amplification as well as an attentuation. At an attentuation a minus sign is put before the figure.
An amplification is the relation between the input and the output signal. In can be valid for voltage, current or power.
When used for power amplification you must remember that current x voltage = power.This means that the relation becomes larger, see the table below.

Examples of fixed dB relations:
For voltage and current:

dB	Amplification
0 dB	1 time
1 dB	1,1 times
3 db	1,4 times
6 dB	2 times (double)
10 dB	3,16 times
20 dB	10 times

The amplification increases logarithmic.

For power:

dB	Amplification
0 dB	1 time
3 dB	2 times
6 dB	4 times
10 dB	10 times
20 dB	100 times

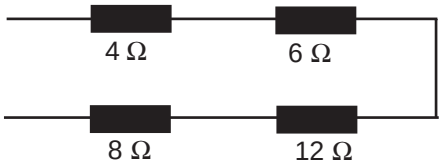
An attentuation of -6 dB is a half for voltage and current and a quarter when talking about power.

CONNECTING RESISTORS

The formualas below is valid when connecting resistors and inductances in series or in parallel. It can also be used for speakers.

IN SERIES:
The total resistance is equal to the sum of all resistors in the connection.

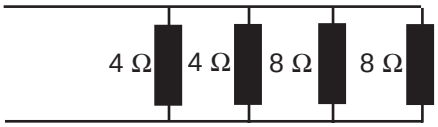
R tot = R1 + R2 + R3 + R4 etc.



R tot = 4 + 6 + 8 + 12 = 30 Ω

IN PARALLEL:
When connecting in parallel the total resistance always becomes lower, it is always lower than the lowest resistor value in the connection.

Formula: $\frac{1}{R} = \frac{1}{R1} + \frac{1}{R2} + \frac{1}{R3} + \frac{1}{R4}$



$\frac{1}{R} = \frac{1}{4} + \frac{1}{4} + \frac{1}{8} + \frac{1}{8}$ R = 1,33 Ω

When connecting only two resistors in parallel you can use the formula below.

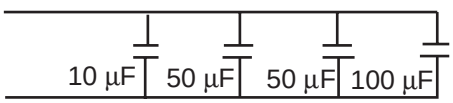
$R = \frac{R1 \times R2}{R1 + R2}$ Ex. $\frac{4 \times 8}{4 + 8} = \frac{32}{12} = 2{,}66\Omega$

CONNECTION OF CAPACITORS

Capacitors acts in the opposite way as resistors when connected in series or parallel.

IN PARALLEL:
The total capacitance when connecting capacitors in parallel is the sum of each capacitor.

C tot = C1 + C2 + C3 + C4 etc.

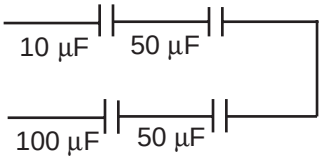


C tot = 10 + 50 + 50 + 100 = 210 µF

1 µF = 0,000001 Farad (10^{-6})
1 nF = 0,000000001 Farad (10^{-9})
1 pF = 0,000000000001 Farad (10^{-12})

IN SERIES:
When connecting capacitors in series you calculate in the same way as for resistors connected in parallel.

Formula: $\frac{1}{C} = \frac{1}{C1} + \frac{1}{C2} + \frac{1}{C3} + \frac{1}{C4}$



$\frac{1}{C} = \frac{1}{10} + \frac{1}{50} + \frac{1}{50} + \frac{1}{100}$ C= 6,66 µF

When connecting only two capacitors you can use the same formula as in the example with two resistors connected in parallel above.

PARAMETERS DLS SPEAKERS

Data 1/1-2000

Model	Fs	Re	Res	Qms	Qes	Qts	Vas	Mms	Cms	Le	BL	Sd	SPL	X max
	Hz	ohm	ohm				liter	gram	µM/Newton	mH	Tesla-M	cm^2	dB	mm
DLS C4/P4	89	2,98	7,32	3,51	1,43	0.67	1,79	6,15	222	0,25	3,31	44,13	82,1	
DLS C5/P5	62	3,09	20,91	4,93	0,73	0,64	6,02	6,94	694	0,29	3,95	78,54	84,8	
DLS C6/P6	63	3,02	14,27	4,62	0,98	0,81	13,49	10,02	645	0,25	3,49	122,0	87,1	
DLS PS4	113	4,23	16,36	4,07	1,05	0,84	1,10	4,89	403	0,18	3,74	44,13	83,7	
DLS PS5	87	4,15	13,65	3,20	0,97	0,75	5,78	6,06	550	0,18	3,76	86,5	87,8	
DLS PS6	65,8	4,15	10,89	3,23	1,23	0,89	14,34	8,65	677	0,20	3,47	122,8	87,0	
DLS 425 slimline	87	4,15	13,65	3,20	0,97	0,75	5,78	6,06	550	0,18	3,76	86,5	87,8	
DLS 426 slimline	65,8	4,15	10,89	3,23	1,23	0,89	14,34	8,65	677	0,20	3,47	122,8	87,0	
DLS 428	56	3,35	34,08	8,29	0,82	0,74	20,34	18,17	442	0,36	5,14	181,0	88,3	
DLS 962	81	3,37	40,89	10,62	0,87	0,81	11,98	13,92	275	0,28	5,23	176,0	90,5	
DLS 960	50					0,59	47,50							
DLS R4/RC4	89	2,87	16,69	5,78	1,00	0,85	1,28	6,79	468	0,26	3,32	44,13	81,4	
DLS R4 Al-cone	96,4	3,43	28,78	7,61	0,91	0,81	1,03	7,23	377	0,26	4,07	44,13	81,9	
DLS R5 Al-cone	61	3,00	7,63	7,21	0,72	0,66	8,11	10,77	633	0,27	4,13	86,50	86,0	
DLS R6 Al-cone	52	3,48	45,00	8,18	0,63	0,59	15,59	12,73	736	0,27	4,78	122,8	87,2	
R8/RC8	37					0,34	43							
R36 4" element	89	2,87	16,69	5,78	1,00	0,85	1,28	6,79	468	0,26	3,32	44,13	81,4	
R36 6" element	54					0,40	11							
T20 tweeter	1500	-	-	-	-	-	-	-			-	-	93	
RC 1 tweeter	950	5,2	-	-	-	-	-	-		0,04	-	-	93	
RC1 from 8-98	950	4,0											91	
U 2,5 mid	350	3,5	-	-	-	-	-	-			-	28	92,5	0,5
U4 bass	80	2,5		3,14	0,74	0,59	4,08	4,3	854	0,18	3,30	61	92	2
U5 bass	61	3,65	26,52	3,55	0,49	0,43	7,77	9,91	683	0,41	5,33	90	87,4	3
U5 bass from 8-98	65	3,6		3,83	0,45	0,40	7,20	7,5	634	0,37	4,75	90	90	3,5
U6 bass	48	3,57	18,79	2,90	0,55	0,46	18,37	11,69	850	0,47	4,80	119,0	87,6	3
U6 bass from 7-96	68	3,30	20,06	3,91	0,64	0,55	7,65	14,08	385	0,42	5,57	119,0	87,6	3
U6 bass from 9-98	60	3,6		4,2	0,63	0,55	16	8,9	800	0,26	4,6	119	90	3,5
UC5 bass	78	3,30		3,49	0,93	0,86	6,5	5,8	571	0,21	2,88	90	89	3
UC6 bass	68	3,3		3,93	1,51	0,97	11	8,13	561	0,16	2,83	119	90	3
UX5	90	3,3		4,90	1,21	0,95	7,80	3,25	674	0,31	2,50	90	89	3
UX6	75	3,3		4,20	1,09	0,86	20	4,40	1017	0,31	2,52	119	90	3
UW 10	38	3,8		2,15	0,52	0,42	77	31,4	525	0,58	7,70	324	91,5	4,25
DLS W108/108C	41,7	3,40	20,56	3,77	0,62	0,54	29,55	22,91	635	0,67	5,72	182,0	87,2	4
DLS W110/110C	39,9	3,37	18,23	3,77	0,70	0,59	49,11	45,14	353	0,65	7,39	314,6	88,3	4
DLS W112/112C	34,5	3,33	21,13	4,32	0,68	0,59	97,77	62,72	339	0,82	8,15	453,0	89,5	4
DLS W108B	40,3	3,34	10,6	1,81	0,57	0,43	27,10	26,65	586	0,45	6,28	181,5	86,7	5
DLS W110B	34,5	3,44	11,26	1,50	0,46	0,35	69,86	42,45	503	0,72	8,31	314,6	89,8	5
DLS W112B	30,7	3,50	12,85	2,03	0,55	0,43	134,9	357,39	470	0,74	8,36	452,3	90,3	5
DLS W310	36,0	3,43		2,49	0,32	0,28	48,6	55,15	349	1,1	11,50	314,6	92	5
DLS W312	30,0	3,43		3,26	0,36	0,34	115,0	79,65	317	1,1	12,22	453,0	93	5
DLS W310B	34,4	3,42	23,98	2,46	0,35	0,31	39,7	74,97	285	0,8	12,58	314,6	89	5
DLS W312B	29,7	3,42	25,03	2,47	0,34	0,30	106	77,8	369	0,72	12,14	452,3	91	5
DLS W510C	28,6	3,38	25,36	3,46	0,30	0,28	68,1	78,7	392	1,60	11,89	314,6	89	9
DLS W512C	30,4	3,31	23,60	3,63	0,31	0,28	109	88,8	308	1,68	13,07	452,3	92	9
DLS W610	32,9	3,58	55,55	3,63	0,23	0,22	40,3	80,72	290	1,58	15,98	314,6	90	9
DLS W612	28,1	3,30	40,45	3,93	0,32	0,30	77,9	118,03	271	1,53	14,66	452,3	89	9
DLS W710	32,4	3,57	71,73	3,76	0,19	0,18	42,9	78,11	308	1,49	17,43	314,6	91	9
DLS W712	28,8	3,24	43,98	3,13	0,23	0,21	80,2	109,3	279	1,43	16,69	452,3	91	9
DLS MW10	35,1	3,23	20,78	2,32	0,36	0,31	28	101,9	202	1,26	14,20	314,6	89	9
DLS MW12	31,7	3.57	32,05	2,14	0,24	0,21	60,2	120,2	210	0,95	18,94	452,3	91	9
DLS MW110	36,7	3,20	16,82	2,34	0,44	0,37	27,5	95,37	197	1,22	12,58	314,6	87	9
DLS MW112	31,8	3,34	18,68	1,71	0,31	0,26	58,8	122,1	205	0,99	16,35	452,3	90	9
DLS X-12	35,7	5,00	73,33	5,16	0,35	0,33	52,4	139,3	143	1,46	21,07	511	90	14
OLDER DLS SUBWOOFERS														
DLS 5508	36					0,40	36							
DLS 5508A	44					0,32	22,9							
DLS 5310/5510	33					0,65	76							
DLS 5310A	49	3,0		2,58	0,52	0,45	46,8	40,8			8,51		92	3
DLS 5310B	35					0,33	81,6							
DLS 5512	28					0,35	280							
DLS 5512A	43	1,9		2,58	0,43	0,37	134	39,1			6,81		98	2
DLS 5612	27					0,39	204							
DLS 5612A	47	2,7		1,65	0,45	0,35	81,0	59,1			11,1		96	3,8
DLS 5615	49	3,2		1,73	0,20	0,18	125	94,1			21,4		100	3,5

Data can be changed without prior notice. On some models some data are missing.

TECHNICAL SPECIFICATIONS GENESIS AMPLIFIERS, series 3.

GENESIS	**Stereo 60**	**Stereo 100**	**Dual Mono**	**Four Channel**
Continuous power output watts RMS, 20 Hz - 20 kHz, 0,1% distortion				
Nom. power in 4Ω	2 x 30 Watt	2 x 50 Watt	2 x 100 Watt	4 x 50 Watt
Typ. power in 4 Ω	2 x 55 Watt	2 x 95 Watt	2 x 150 Watt	4 x 95 Watt
Nom. power in 2 Ω	2 x 60 Watt	2 x 100 Watt	2 x 200 Watt	4 x 100 Watt
Typ. power in 2 Ω	2 x 85 Watt	2 x 145 Watt	2 x 250 Watt	4 x 145 Watt
Nom. power, 4 Ω bridge	1 x 120 Watt	1 x 200 watt	1 x 400 watt	2 x 200 Watt
Typ. power 4Ω bridge	1 x 170 Watt	1 x 290 Watt	1 x 500 Watt	2 x 290 Watt
S / N ratio, A-weighted	>100 dB	>100 db	>100 dB	>100 dB
Damping factor	>200	>200	>200	>200
Input impedance	>10 k	>10k	>10k	>10k
Input sensitivity	0,3 - 5V	0,3 - 5V	0,3 - 5V	0,3 - 5 V
Filter high-pass	20-200 Hz	20-200 Hz	20-200 Hz	20-200 Hz (K1 - 4)*
Filter low-pass	Fixed 80 Hz*	50-200 Hz*	50-200 Hz*	50-200 Hz (K1 - 4)*
Fan output terminal	No	Yes	Yes	Yes
* Switchable in/out				
Current draw:				
Idle	1,0 A	1,6 A	2,5 A	2,0 A
Typical	5 A	7 A	12 A	10 A
Maximum	23 A	37 A	58 A	75 A
Dimensions (mm)	150x210x62	200x210x62	300x210x62	360x210x62
Weight	1,6 kg	2,1 kg	3,2 kg	3,75 kg

GENESIS	**Monoblock**	**Five Channel**	
RMS output power per channel at 14,4 volt, 20 Hz - 20 kHz, < 0,1% distortion, (Monoblock at 0.01%)			
Nom. power in 4Ω	250 Watt	4 x 40 Watt	Sub channel: 140 Watt
Typ. power in 4 Ω	400 Watt	4 x 55 Watt	Sub channel: 155 Watt
Nom. power in 2 Ω	500 Watt	4 x 60 Watt	Sub channel: 200 watt
Typ. power in 2 Ω	750 Watt	4 x 80 Watt	Sub channel: 260 Watt
Nom. power in 1 Ω	1000 Watt	-	Sub channel: 300 Watt
Typ. power in 1 Ω	1200 Watt	-	Sub channel: 360 Watt
Bridge mode 4Ω nom.	-	2 x 150 Watt	
Bridge mode 4Ω typical	-	2 x 160 Watt	
Damping factor	>500	>200	
S / N ratio, A-weighted	>100 dB	>100 dB	
Input sensitivity	0,3 - 5V	0,3 - 5V	
Input impedance	>10 k	>10 k	
Filter high-pass	Nej	80-400Hz + 15-40 Hz*	* Switchable in/out
Filter low-pass	50-125 Hz	400Hz-40k + 50-125 Hz*	
Fan output terminal	Yes	Yes	
Current draw:			
Idle	3,0 A	3,0 A	
Typical	30 A	12 A	
Maximum	170 A	80 A	
Dimensions (mm)	450x210x62	450x210x62	
Weight	5,0 kg	4,75 kg	

Recommended cable size for the DC-feed:

Cable length:	**<1,5 m**	**1,5 - 5 m**	**> 5 m**
Stereo 60	6 mm^2	10 mm^2	16 mm^2
Stereo 100	10 mm^2	16 mm^2	21 mm^2
Dual Mono	16 mm^2	21 mm^2	33 mm^2
Four Channel	16 mm^2	21 mm^2	33 mm^2
Five Channel	16 mm^2	21 mm^2	33 mm^2
Monoblock	33 mm^2	33 mm^2	42 mm^2

Max fuse value for different cable sizes:

6 mm^2	=	9AWG	25A
10 mm^2	=	7AWG	40 A
16 mm^2	=	5AWG	60 A
21 mm^2	=	4AWG	100 A
33 mm^2	=	2AWG	140 A
42 mm^2	=	1 AWG	200 A

Recommended main fuse for amplifiers:

Amplifier	**Fuse**	**Fuse holder**
Stereo 60	25 A	FH1
Stereo 100	40 A	FH1
Dual Mono	50 A	FH1
Four Channel	60 A	FH1
Five Channel	60 A	FH1
Monoblock	125 - 150 A	FH2

TECHNICAL SPECIFICATIONS GENESIS AMPLIFIERS, series 2

AMPLIFIERS IN CLASS AB:

GENESIS	**B-40**	**SM-60**	**SM-100**	**DM-200**	**Q-200X**
Continuous power output watts RMS, 20 Hz - 20 kHz, 0,1% distortion					
Nom. power in 4Ω	2 x 20 W	2 x 30 W	2 x 50 W	2 x 100 W	4 x 50 W
Typical power in 4 Ω	2 x 30 W	2 x 45 W	2 x 75 W	2 x 130 W	4 x 70 W
Nom. power in 2 Ω	2 x 40 W	2 x 60 W	2 x 80 W	2 x 150 W	4 x 90 W
Typical power in 2 Ω	2 x 50 W	2 x 80 W	2 x 110 W	2 x 200 W	4 x 120 W
Bridge mode 4Ω nom.	60 Watt	120 Watt	160 Watt	300 Watt	2 x 180 W
Bridge mode 4Ω typical	90 Watt	150 Watt	240 Watt	425 Watt	2 x 240 W
S / N ratio, better than	100 dB	100 dB	100 db	100 dB	100 dB (A-weigthed)
Channel separation	60 dB	70 dB	70 dB	70 dB	60 dB
Input variable	0,2 - 3V	0,2 - 3V	0,2 - 3V	0,2 - 3V	0,2 - 3V
Power consumption:					
idle	0,4 A	0,5A	0,8A	1,2A	1,3A
4Ω nom. power	8A	13A	19A	45A	45A
2Ω nom. power	16A	24A	35A	65A	65A
Dimensions (mm)	100x190x62	125x177x62	165x192x62	260x192x62	320x192x62

AMPLIFIERS IN CLASS "A":

GENESIS	**SA-30**	**SA-50**	**DA-100**	**Q-100X**	**P-300X***
Continuous power output watts RMS, 20 Hz - 20 kH, 0,1% distortion					
Nom. power in 4Ω	2 x 15 W	2 x 25 W	2 x 50 W	4 x 25 W	4x40 W + 1 x 100 W
Typical power in 4 Ω	2 x 25 W	2 x 45 W	2 x 85 W	4 x 45 W	4 x 53 W + 1 x 130 W
Nom. power in 2 Ω	2 x 30 W	2 x 50 W	2 x 100 W	4 x 50 W	4 x 60 W + 1 x 200 W
Typical power in 2 Ω	2 x 45 W	2 x 75 W	2 x 140 W	4 x 75 W	4 x 78 W + 1 x 220 W
Typical power in 1 W					1 x 300 W
Bridge mode 4Ω nom.	60 Watt	100 Watt	200 Watt	2 x 100 Watt	2 x 100 W
Bridge mode 4Ω typical	100 Watt	160 Watt	300 Watt	2 x 160 Watt	2 x 130 W
S / N ratio, better than	100 dB	100 dB	100 db	100 dB	105 dB
Channel separation	70 dB	70 dB	70 dB	70 dB	70 dB
Input variable	0,2 - 3V	0,2 - 3V	0,2 - 3V	0,2 - 3V	0,2 - 2V
* P300X subchannel works in class AB					
Power consumption:					
idle	1,3 A	1,7A	3,3A	3,4A	3,8A
4Ω nom. power	8A	12A	22A	24A	
2Ω nom. power	16A	23A	33A	46A	87A
Dimensions (mm)	125x177x62	165x192x62	260x192x62	320x192x62	450x192x62

BUILT-IN FILTERS

Q-100x, Q-200x and P-300X are equipped with built-in 12 dB variable electronic crossovers.
Low-pass variable 60 - 150 Hz
High-pass variable 80 - 200 Hz
P-300X: K1-2: HP 80-200 Hz / 2,4 kHz - 6 kHz
K3-4: HP 80 - 200 Hz + LP 3 kHz - 40 kHz
K5: HP 15 - 40 Hz + LP 50 - 125 Hz
The high-pass filters on channel 1-2 and 3-4 can be switched in-out.

REC. CABLE SIZES FOR THE DC-FEED

Cable length:	**<1,5 m**	**1,5 - 5 m**	**> 5 m**
B-40/SA-30/50	6 mm^2	10 mm^2	16 mm^2
SM-60/SM-100	6 mm^2	10 mm^2	16 mm^2
DA-100/DM-200	10 mm^2	16 mm^2	21 mm^2
Q-100X	10 mm^2	16 mm^2	21 mm^2
Q-200X	16 mm^2	21 mm^2	33 mm^2
Mono-250/P-300X	16 mm^2	21 mm^2	33 mm^2

TECHNICAL SPECIFICATIONES OF DLS AMPLIFIERS

MODEL	**DS 100/Reference 100**	**DQ 200/Reference 200**
Number of channels	2	4
Mode	AB	AB
RMS output power at 13,5 VDC, 20 Hz - 20 kHz, max 0,1% THD:		
4 ohm nominal power	2 x 50 Watts	4 x 50 Watts
4 ohm max effekt	2 x 65 Watts	4 x 60 Watts
2 ohm max effekt	2 x 100 Watts	4 x 80 Watts
Bryggkoppling 4 ohm	220 Watts	2 x 180 Watts
THD	< 0,1%	< 0,1%
S/N ratio, A-weighted	> 100 dB	> 100 dB
Damping factor	> 200	> 200
Input impedance	15 kohm	15 kohm
Input sensitivity	0,3 - 5,5 volt	0,3 - 5,5 volt
Filter highpass	15 - 200 Hz	15 - 200 Hz
Filter lowpass	50 - 200 Hz*	50 - 200 Hz*
* Can be switched in/out		
Filter slope	12 dB/octave	12 dB/octave
Fuses	25 A x 2	25 A x 2
Max power cable area power:	16 mm^2	16 mm^2
Max speaker cable area	6 mm^2	6 mm^2
Protection circuits	Current and thermal	Current and thermal
Power consumption:		
Idle	0,7 A	1,0 A
Max consumption	37 A	55 A
Remote	26 mA	26 mA
Dimensions:		
Width	290 mm	400 mm
Heigth	65 mm	65 mm
Depth	240 mm	240 mm
Weigth	4 kg	5,4 kg

Recommended cable size for the DC-feed.

Cable length:	< 1,5 m	1,5 - 5 m	> 5 m
Amplifier:			
DS 100	10 mm^2	16 mm^2	21 mm^2
DQ 200	16 mm^2	21 mm^2	33 mm^2

Recommended main fuse:

Amplifier	**Fuse**	**Fuse holder**
DS 100	AGU 40 A	FH1/FH1B
DQ 200	AGU 60 A	FH1/FH1B

CROSSOVER FILTERS

The ideal speaker element that can reproduce all frequencies from lowest bass to highest treble is not yet invented. Instead we have to use two or more speakers where each speaker is adapted to a part of the frequency range.
To make this work the input signal to each speaker element must contain only the frequencies it´s designed for. For this purpose we need crossover filters.

ACTIVE CROSSOVERS

Crossovers can be ACTIVE or PASSIVE. An active filter is connected before the amplifier line input. You need one amplifier for each speaker pair which will become rather expensive.
But the advantages are that it´s possible to mix speakers with different impedance or sensitivity and still be able to balance the system.
Most 4, 5 and 6-channel amplifiers are equipped with built-in active crossovers that can be adjusted in frequency and switched in-out.
GENESIS Q-100X, Q-200X and P-300X are equipped with these features. All GENESIS series 3 amplifiers are equipped with built-in active crossovers

PASSIVE CROSSOVERS

Passive crossover consists of coils and capacitors, and sometimes resistors for impedance adaption. A passive filter is connected between the amplifier and the speaker and is of LC-type, (coil and capacitor).

A coil stops the higher frequencies while the low passes through, a capacitor works in the opposite way. By changing the component values, different crossover frequencies are obtained. The coils must be of high quality with a large wire area to avoid losses and distortion. Air coils without iron core are the best but they can be rather big for high values. For high values we often use coils with an iron core. The best capacitors are of polyester type. For large capacitance values bipolar electrolytic capacitors are used.
Resistors are used in a filter for impedance adaption. Read the part about conjugate compensation.
A passive filter steals more power than an active.

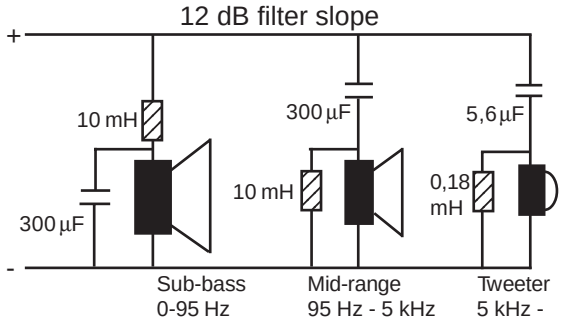
CROSSOVER FREQUENCIES:

In a two-way system with separate tweeter a crossover frequency from 3 - 8 kHz is normal.
In a three-way system it´s normal to split the sub at 200-400 Hz and the tweeter at 3 - 8 kHz.
In a four-way system the x-over frequencies can be as follows. To the subwoofer 80-130 Hz, mid-bass 400-600 Hz and the tweeter 3 - 8 kHz.
This is a just a recommendation. Depending upon the speaker data and where the different elements are mounted in the car, other x-over frequencies could be better.

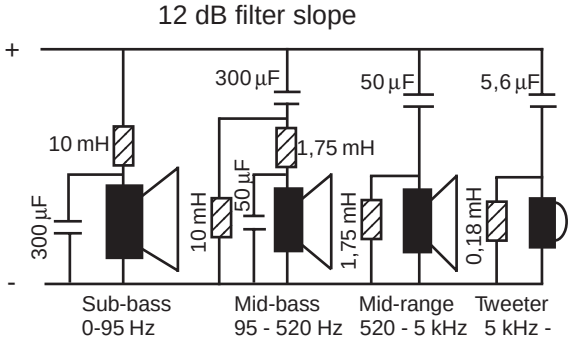
CROSSOVER EXAMPLES:

(without conjugate compensation)

3-WAY SYSTEM:



4-WAY SYSTEM:



The systems above are shown without impedance compensation. Read below about conjugate links.

PHASE SHIFT IN CROSSOVER FILTERS

All passive crossovers will phase shift the signal.
A 6 dB filter shifts 90 degrees and a 12 dB 180 degrees. Because of this you should always try to phase reverse the tweeter in a system to see what phase is creating the best sound. In a 3-way system it´s normal to phase reverse the tweeter. All tweeters used in a system must have the same polarity (phase). Also subwoofers with a 12 dB crossover should you try to phase reverse. If the subwoofer cone is moving but you don´t achieve any good bass you can try to phase reverse. If two subwoofers are connected with different polarity (phase), the sound from each speaker will kill the sound from the other, resulting in a poor bass reproduction.

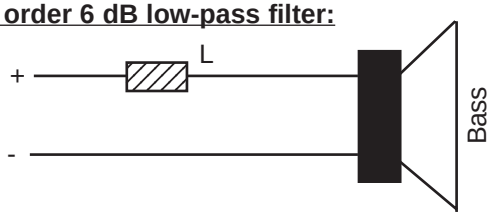
CONJUGATE COMPENSATION:

Conjugate compensation is a way to equal the speaker load over the whole frequency range. A 4 ohm speaker can have an impedance peak up to 25 times the normal at the resonant frequency (Fs). To make the calculated crossover filter to match, you can connect a conjugate link in parallel with the speaker. It´s normally made of a capacitor and a resistor. If you cant calculate the exact component values for the conjugate link you can use a 33 µF capacitor in series with a 3,9 ohm resistor to most 4", 5,25" and 6,5" speakers.

PASSIVE 6 dB LOW-PASS

A 6 dB x-over filter has a 6 dB slope / octave. The output from an amplifier is only a quarter after falling with 6 dB. A 6dB filter is also called 1:st order filter.
A common use for a 6 dB low-pass filter is for a subwoofer to stop frequencies over, as for example, 100 Hz.
A 6 dB low-pass filter consists of a coil. The x-over frequency is decided by the inductance value measured in the unit Henry (H) and parts of a Henry. For speakers we normally use coils with the unit mH.
1 H = 1000 mH.

1:st order 6 dB low-pass filter:



CALCULATION FORMULA:

$$L\ (mH) = \frac{160 \times Z}{Fc}$$

Z = speaker impedance in Ω
Fc = x-over frequency in Hz
L= Coil inductance in mH

When connecting coils in series the values are added.
Use this formula when connecting in parallel:

$$\frac{1}{L} = \frac{1}{L} + \frac{1}{L} + \frac{1}{L}$$

Inductance values for different x-over frequencies:

X-over fq. Hz	Speaker impedance 2Ω L (mH)	4Ω L (mH)	8Ω L (mH)
65	5	10	20
80	4	8	16
100	3,2	6,4	12,8
130	2,5	5	10
200	1,6	3,2	6,4
360	0,9	1,75	3,5
500	0,65	1,3	2,6
800	0,4	0,8	1,6
1000	0,32	0,64	1,28

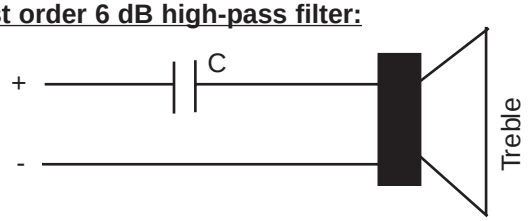
X-over frequencies at given values:

	10 mH	6,3 mH	1,75 mH
2Ω	32 Hz	50 Hz	183 Hz
4Ω	64 Hz	101 Hz	365 Hz
8Ω	128 Hz	203 Hz	730 Hz

PASSIVE 6 dB HIGH-PASS

A 6 dB high-pass x-over filter consists of a capacitor. The crossover frequency varies with the capacitor value that is measured in the unit Farad and parts of Farad. Normally we use µF values for speakers.,
1 F = 1000 000 µF
Capacitor values from approx. 10 µF and up are normally of bipolar electrolytic type. For lower values we often use polyester capacitors. A capacitor as in the drawing below let the high frequencies pass and stops the lower.

1:st order 6 dB high-pass filter:



CALCULATION FORMULA:

$$C\ (\mu F) = \frac{160000}{Fc \times Z}$$

Z = speaker impedance in Ω
Fc = x-over frequency in Hz
C = Capacitor value in µF

When connecting capacitors in parallel the values are added. Use this formula when connecting in series.

$$\frac{1}{C} = \frac{1}{C} + \frac{1}{C} + \frac{1}{C}$$

Capacitor values for different x-over frequencies:

X-over fq. Hz	Speaker impedance 2Ω C (µF)	4Ω C (µF)	8Ω C (µF)
80	1000	500	250
100	800	400	200
130	600	300	150
200	400	200	100
500	160	80	40
800	100	50	25
1000	80	40	20
2000	40	20	10
5000	16	8	4

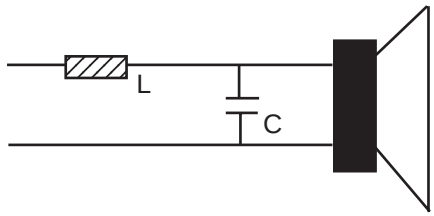
X-over frequencies at given values:

	300 µF	200 µF	150 µF	50 µF	6,8 µF
2Ω	266 Hz	400 Hz	533 Hz	1,6 kHz	11,7 kHz
4Ω	133 Hz	200 Hz	266 Hz	800 Hz	5,85 kHz
8Ω	67 Hz	100 Hz	133 Hz	400 Hz	2,92 kHz

PASSIVE 12 dB LOW-PASS

A 12 dB x-over filter has a 12 dB slope / octave.
A 12 dB filter is a combination of a coil and a capacitor. It is also called 2:nd order filter. 12 dB low-pass filters are often used for subwoofers in order to stop frequencies over the x-over frequency, for example 100 Hz. A combination of a low- and high-pass filter is called a band-pass filter.

2:nd order 12 dB low-pass filter:



CALCULATION FORMULA:

$L\ (mH) = \frac{225 \times Z}{Fc}$ $C\ (\mu F) = \frac{112500}{Fc \times Z}$

Z = speaker impedance in Ω
Fc = x-over frequency in Hz
L = coil inductance in mH
C = capacitor capacitance in µF

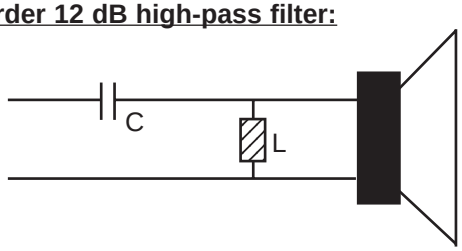
When connecting coils in series the values are added. Use this formula when connecting in parallel:

$\frac{1}{L} = \frac{1}{L} + \frac{1}{L} + \frac{1}{L}$

PASSIVE 12 dB HIGH-PASS

The difference between the passive 12 dB high-pass x-over filter and the low-pass filter is that the coil and capacitor change place. For a certain x-over frequency the component values are the same for both high- and low-pass filters. A high-pass filter let high frequencies pass, and stops the lower.

2:nd order 12 dB high-pass filter:



CALCULATION FORMULA:

$L\ (mH) = \frac{225 \times Z}{Fc}$ $C\ (\mu F) = \frac{112500}{Fc \times Z}$

Z = speaker impedance in Ω
Fc = x-over frequency in Hz
L = coil inductance in mH
C = capacitor capacitance in µF

When connecting capacitors in parallel the values are added. Use this formula when connecting in series.

$\frac{1}{C} = \frac{1}{C} + \frac{1}{C} + \frac{1}{C}$

COMPONENT VALUES FOR 12 dB PASSIVE CROSSOVERS

X-over freq. in Hz	2 Ω		4 Ω		8Ω	
	C (µF)	L (mH)	C (µF)	L (mH)	C (µF)	L (mH)
62,5	900	7,2	450	14,4	225	28,8
95	600	5	300	10	150	20
140	400	3,2	200	6,4	100	12,8
190	300	2,35	150	4,7	75	9,5
375	150	1,2	75	2,4	38	4,8
520	108	0,87	54	1,75	27	3,5
800	70	0,56	35	1,12	18	2,25
3500	16	0,12	8	0,25	4	0,5
5000	11	0,09	5,6	0,18	2,8	0,36

The same component values are used for both high- and low-pass filters, but they change place.

Use coils with low resistance, air coils are the best. Coils with iron core must be able to handle high current or the iron core magnetic saturation becomes to high causing distortion.
Capacitors must be of bipolar type, 50 - 100 Volt.

IMPORTANT WHEN CONNECTING FILTER !
When connecting a 12 dB low-pass x-over to a subwoofer it´s suitable to solder the capacitor directly on the sub terminals between + and -.
If the sub is disconnected without disconnecting the capacitor at the same time the amplifier can be damaged.
A 12 dB filter connected without a speaker will overload the amplier (if it´s turned on) and damage the output circuits.

THE CABLES - AN IMPORTANT LINK

No chain is stronger than it´s weakest link !
It´s not unusual that people buy expensive amplifiers and speakers but forget the wiring. DLS have high quality cables for both amateurs and professional users.

Cables made of oxygen free copper (OFC).
Cables made of oxygen free copper will not oxidize as normal copper do. The oxidation increases the DC-resistance and as a result of this the voltage drop in the cable. All DLS cables use oxygen free copper.

DLS POWER CABLES.
As we have said before the DC-feed to the amplifier is of great importance. The amplifier must in all occasions have enough current, otherwise both the dynamics and good sound will be lost.
DLS power cables of oxygen free copper are made of a lot of small cores to make it soft and flexible with lowest DC-resistance. Use the table below to choose the correct DC-feed.

Cable length:	<1,5 m	1,5 - 5 m	> 5 m
DLS DS 100	10 mm²	16 mm²	21 mm²
DLS DQ 200	16 mm²	21 mm²	33 mm²
Stereo 60	6 mm²	10 mm²	16 mm²
Stereo 100	10 mm²	16 mm²	21 mm²
Dual Mono	16 mm²	21 mm²	33 mm²
Four Channel	16 mm²	21 mm²	33 mm²
Five Channel	16 mm²	21 mm²	33 mm²
Monoblock	33 mm²	33 mm²	42 mm²

In many installations the current capacity is improved with extra batteries (OPTIMA) with low inner resistance or large 1 Farad capacitors, DLS Power Caps. If you don´t want to spend money on extra batteries at least you shouldn´t save money on the DC-feed.

DLS SPEAKER CABLES.
Also the speaker feed must be of high quality. Use cables with an area of at least 1,5 mm².DLS speaker cables are soft and flexible with a construction that minimizes the loss over the whole frequency range.

DLS SC 4x1 and SC 4x1,5 are special speaker cables with four leads. They are twisted and has a powerful insulation protecting them from mechanical agitation.
The four leads are connected in pairs as they have different strand sizes using the skin effect to minimize the resistance on all frequencies.
The capacitance, inductance and EMF are reduced by the twisted cores in the cable.
Two of the four leads have a strand size of 0,1 mm², and the two others have 0,2 mm².

DLS SC 2x1,5, SC 2x2,5 and SC 2x4 are the standard two-lead speaker cables made of oxygen free copper. They have twisted strands and are soft and flexible for easy installations.

SKIN-EFFECT AND INDUCTANCE

In a conductor the higher frequencies moves on the surface, while lower frequencies moves in the center of the cable. To make the active resistance (impedance and inductance) as low as possible for each frequency some cables use different strand sizes for different frequencies. Higher frequencies prefer a cable with very thin strands while the lower frequencies will find the lowest active resistance in a thicker strand. To minimize the cable resistance further the cable can be designed with a combination of copper and silver plated strands.
One of the advantages with DLS speaker- and signal cables are the low inductance. Opposite an ordinary DC-resistance the inductance is linear. It means that higher frequencies will be more supressed than the lower which can create a distored and false sound reproduction. Inductance will occour when an AC-current flows in an electromagnetic field. These fields are causing eddy currents superposed the normal current leading to an increase of resistance. They also make the current flow to decrease towards the center of the conductor (skin-effect). A low inductance is to prefer. This is achieved by using raw materials with high purity. A low inductance will also be achieved by twisting the strands in the conductor. When the current to the speaker passes through the speaker coil, which is an inductance, it creates eddy currents that goes back to the amplifier called counter- Electro Motive Force (EMF). The EMF is also reduced by a correct cable construction with twisted strands.

DLS speaker cable design gives the following advantages:
- ❑ Maximum reduction of the EMF which causes phase shift resulting in bad sound quality.
- ❑ Lowest possible damping resistance on all frequencies by using the skin effect.
- ❑ Lowest possible power loss.

SIGNAL CABLES:
The signal cables must be of good quality as well as the speaker cables.
The construction of the cable must have the best possible reduction of inductance and capacitance together with a low damping over the whole frequency range.
The shielding is also important to avoid interference noise from the electric system of the car.
DLS **SL2PRO** and **SL5PRO** are triple shielded but without a remote wire. A remote wire included with the signal cable may induce interference. These cables are also quasi-balanced for maximum performance.
Also use RCA phono connectors of highest quality with good shielding and gold plated for minimum contact resistance.

INSTALLATION

THE HEAD UNIT

The heart in a car stereo installation is the car stereo, often called head unit. Today it´s normally a tuner with an external CD-changer or built-in CD-player. The well-known brands are the best choice if you want a high quality product.
One important detail is to buy a head unit with RCA pre-outs which makes it easier when you want to do a more sophisticated installation than standard. The head unit is normally installed in the dash-boards original fitting, just make sure it´s fastened properly. If possible use heavier DC-feeds than the originals used in the car. If you use the internal amplifier to feed any speaker pair this is important. The ground wire must have the same area as the +-feed.
If you have interference noise from the alternator or ignition its´often the ground connection that is wrong. Try different places for the ground connection, the best is close to a unit (the amplifier).

THE AMPLIFIER

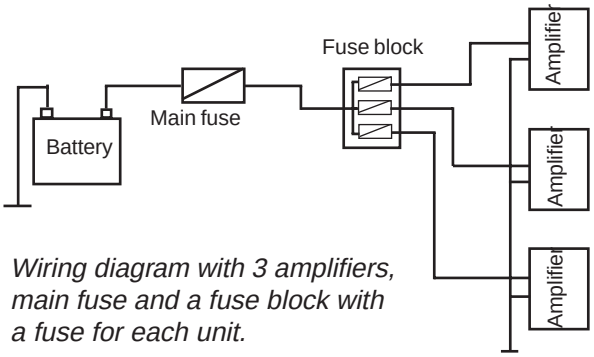
An extra amplifier should be installed in a place where it can be satisfactory cooled. Many amplifiers get very hot and need a good cooling.
In some installations you might need one or two external cooling fans.
First check if there are any cable mats or fuel pipes behind the place where you plan to mount the amplifier. Alternatively use an extra particle board or the bass box when you mount the amplifier and you will have a better ground insulation. To avoid interference noise this can be to prefer.
Install the amplifier far away from your radio aerial. Sometimes the amplifiers DC/DC-converter generates high frequency interference.

THE CABLES

As we have said before the cables are very important. In the table on page 5 you find recommended areas for the DC-feed for different amplifiers. The ground wire must have the same area as the +-wire. Connect the ground wire as close as possible to the amplifier. Connect all units in the system to the same ground point to avoid interference.
Use high quality speaker cables with an area of at least 1,5 mm^2 to the side systems and 2,5 mm^2 to the subwoofers, (or more).
Signal cables must have good shielding, otherwise they can pick up interference noise.
Avoid to place the power cables on the same side of the car as the signal cables. Also try to avoid the cars own cable mats to come close to the signal cables.
Any extra cable must be laid out in zig-zag style and definitely not coiled.
Don´t let the cables pass sharp edges that can hurt the cable insulation causing short circuits or other problems.

THE DC-FEED

To avoid damage to the amplifier or the electric system of the car the DC-feed installation must be made with care. A main fuse should be installed close to the battery. The fuse value depends on what kind of amplifier / amplifiers you use, but a fuse value of 40 - 60 A is normal.
Use either glass fuses or automatic circuit breakers. If the amplifiers are installed in the back of the car it´s normal to install a separate fuse block from which you distribute the power to the separate units. Each unit will then be separately fuse protected. See the drawing below.



Wiring diagram with 3 amplifiers, main fuse and a fuse block with a fuse for each unit.

The main fuse holders use either a glass fuse of AGU-type (max 80A), or ANL-fuses with values up to 250 Amps. There are fuse blocks for 2, 3 or 4 AGU fuses.
Automatic circuit breakers is another good alternative as main fuse. They also have a test button with which you easily can switch off the power to all units.
The ground wires from all units can easily be connected together with a power block type PB1.

For best function with lowest possible DC-resistance in all connection points, all the above products are gold plated with 24 K gold. Besides of a good function it´s also gives a good impression.

EXTRA BATTERY

In many exclusive installations, and most competition cars, extra batteries are installed. Sometimes also extra alternators for improved charging, or extra capacitors of 0,5 or 1 Farad value.
The purpose of this is to make sure that the amplifiers always gets enough current even at very high volumes, otherwise the sound will be destroyed at high volumes.
For a normal listener the ordinary car battery is sufficient. Just make sure you have DC-feeds that´s big enough. But if you plan to compete or just want to get the most out of your equipment it´s always right to install an extra battery or extra capacitors that works as a current reservoir.
These extra batterys are of a special type with low internal resistance that can handle large current flows.

SPEAKER INSTALLATION

An important part of the installation is of course the speakers.
How they are installed varies from car to car and depends upon the possibilities in each type.
The factory pre-made installation holes are not always ideal for other types of speakers than original. We will give you some hints of what to think of when installing speakers.

ORIGINAL INSTALLATION
The easiest way to install a speaker in a car is to use the factory pre-made holes. If you use car specific speakers, the installation job becomes very easy. But the problem is that these type of speakers are usually not of the highest quality and will not satisfy a demanding listener.
The high quality speakers often have large magnets making it necessary to first measure the space and sometimes make changes in the door or dash-board to make them fit. Especially the depth is important to check so that the side windows goes clear from the magnet.
Some car models requires special adaptors or distances to make the speaker fit when you use other speakers than the original.
If possible use some kind of baffle on the back of the door panel. Make sure the baffle is fastened properly and fasten the speaker in the baffle. This is easy to make and will normally result in a better sound than without baffle.
A speaker installation high up on the door-side is to recommend, but if the pre-made hole is at the bottom part of the door it´s difficult to change.
A 2/3-way system should be installed with the elements close to each other to achieve the best sound image. An alternative is to install the bass element in the door and the tweeter on the dash-board.
A door or dashboard installation is actually an "open-air" installation since there is no limiting box.

ORIGINAL MOUNTING:

ADVANTAGES:
- Fast, easy and simple

DISADVANTAGES:
- The speakers have no baffle = rattle.
- Bad power handling capacity.
- Bad sound image.
- No box to the speaker element.

Exemple of a door installation with new baffles.

NEW DOOR BAFFLES
If you want to improve your door installation you should build a new door-side. This must be adapted to the door side and is normally made of MDF or particle board. The baffle is covered with cloth or vinyl matching the car interior. Some car sound builders changes the whole door-side to a new one. The speaker element is directed to obtain the best sound image. They are also fastened properly to avoid rattle.
They are normally mounted with a sealed speaker box behind the elements. The volumes needed for a 4" or 5,25" element are only a few liters.

BAFFLE MOUNTING:

ADVANTAGES:
- The speakers are mounted in real baffles.
- A box construction that improves the sound quality with less rattling.
- Higher power handling capacity.
- Better sound image (front stage).

DISADVANTAGES:
- More work and more expensive mounting.
- The cars original door sides are affected.
- The installation requires a lot of knowledge to make the installation to look professional.

KICK-PANELS

Another installation alternative giving a good sound image is the kick-panel. It´s placed down on the floor in front of the door on both sides. It can contain the whole system with bass, midrange and tweeter or a bass and midrange with the tweeter installed on the dashboard. The best places for the speakers must be tested out in the respective car.

Kick-panels are normally made of MDF or particle board and are build as sealed boxes or as membrane boxes where the element is allowed to breath through a membrane of foam rubber or similar.

Kick-panels are very popular in competition cars.

MOUNTING IN KICK-PANELS:

ADVANTAGES:

- Stable mounting without rattling.
- Superb sound image.
- Higher power handling capacity.
- Less affection on the cars interior.

DISADVANTAGES:

- More mounting work.
- Possibilites to damage the speaker if kicking on them with the feets.

HIGH MOUNTED KICK-PANELS:

In some cars the kick-panel can be mounted invisible up under the dashboard. Can create a good sound image despite the strange mounting.

DASHBOARD MOUNTING

A mounting of the midrange and tweeter up on the dashboard will result in an improved sound image. It will be moved up on the dashboard. Some cars that have suitable original dashboard mounting holes can be used.

The tweeters should be mounted on the dashboard or on the door poles. The woofer elements should be mounted in a door-side or in a kick-panel. Suitable for DLS U-35/U-36 or R36/RC36.

REAR FILL

A well mounted front system is the most important in a sound system. In some cases we also use rear mounted speakers used as "rear fill". Rear fill speakers will improve the front stage image by adding a weak sound from the rear filling up the sound stage and giving it a deep. As Rear fill speakers we can use midrange elements in combination with a passive or active bandpass filter, mounted in the rear. A suitable frequency response can be from 500 - 6000 Hz. The level must be dampened easiest made with a series resistor of 10 - 20 ohms in series with the + lead. The rear fill speaker can also be connected in multimode. In this case you use only one element working as a center channel speaker.

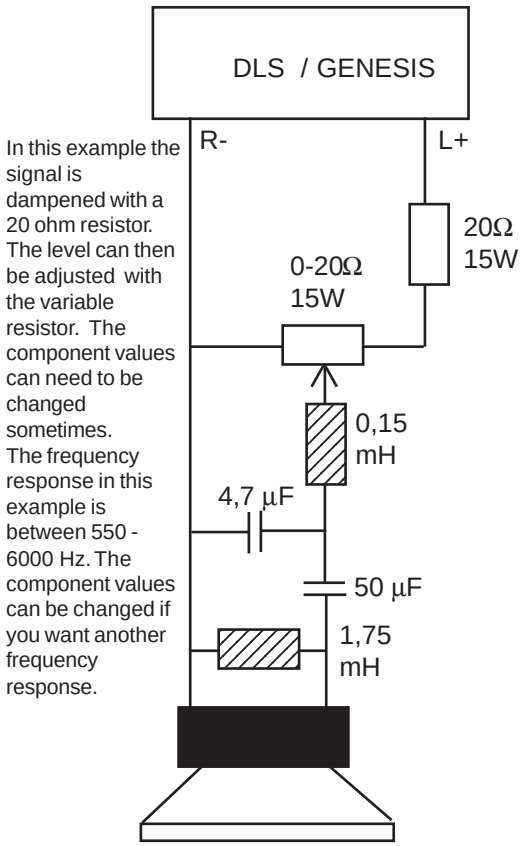
Kick-panel

CENTER CHANNEL SPEAKER

A center channel speaker can be used to improve the sound image in installations where the speaker mounting makes it difficult to achieve a correct sound image.

On a DLS or GENESIS amplifier you connect the center channel speaker in bridge mode between left and right channel and then you obtain the sum signal of both channels.

It can be mounted on the middle of the dashboard.


DLS / GENESIS
R-
L+
20Ω
15W
0-20Ω
15W
0,15
mH
4,7 µF
50 µF
1,75
mH
In this example the signal is dampened with a 20 ohm resistor. The level can then be adjusted with the variable resistor. The component values can need to be changed sometimes. The frequency response in this example is between 550 - 6000 Hz. The component values can be changed if you want another frequency response.

Center channel speaker 4 ohm

HAT-RACK MOUNTING

The best sound stage for front seat listeners is achieved with door- or kick-panel mounting. In competition cars the front system combined with rear subwoofers are often the only speakers. Sometimes they are combined with a pair of small 4" or 5,25" speakers in the back used as "rear fill". These rear fill speakers are connected with x-overs giving a reproduction from 1-2 kHz and up. Tweeters are normally not used in combination with rear fill.

The traditional hat-rack mounting with a system or 6x9" speakers requires some installation work to create a good sound.
A new hat-rack made of particle board (22 mm) or MDF-board (19 mm) must be produced. The original hat-racks are normally not sufficient to use.
If you furthermore want the speakers to have a high power handling capacity you need to make some kind of speaker box (normally of sealed type) on the back of the hat-rack, limiting the cone movement.
If you have a bass box in your trunk it´s necessary to have a box for the hat-rack speakers. If not, the low bass from the sub will have an influence on the speaker cones and destroy the sound.

In many installations you must use passive filters to the different speakers in your system. Later in this book there are some wiring examples where passive filters are used.

SUBWOOFER INSTALLATION

An "open air" subwoofer installation in the hat-rack or towards the back seat calls for the same baffles of particle board or MDF-board as described above. But the best result is normally achieved using a separate bass box of some type. Later in this book we will describe different types of boxes and give advices of how to build a box.
You will also find suitable box sizes for all DLS subwoofers.

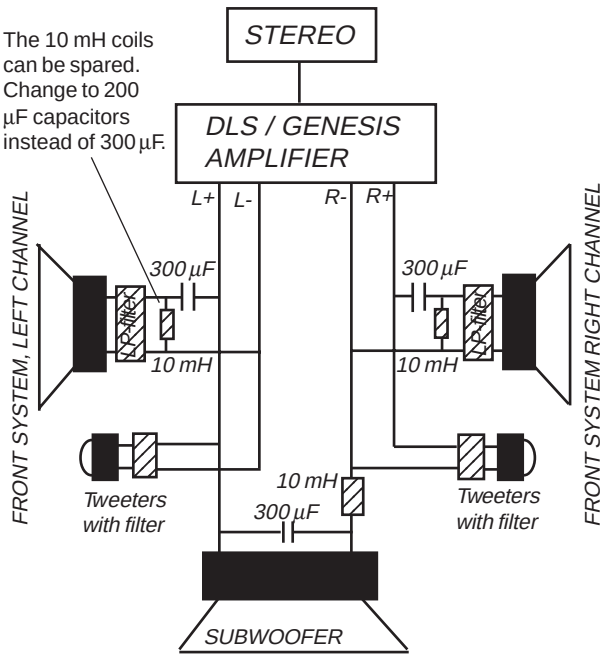
DLS / GENESIS IN MULTIMODE

All DLS and GENESIS (except for MONO 250) can be used in multimode operation. Multimode means that you from one amplifier can take three different signals, left channel, right channel and the sum of right and left channel.
To the sum signal you can connect one or more subwoofers through a passive low-pass crossover. You can also connect a center-channel speaker in multimode. (See example on page 18).
The stereo connected speakers can be either a 2/3-way system or coaxial speakers. To this speakers you must use passive high-pass filters that limits the frequency response.
The advantages of multimode operation is that a single amplifier can be used for all speakers in the car. It´s easy to install, it needs less space and it´s cheaper. The disadvantages is that you need passive crossovers and it´s difficult to adjust the sound balance between the front system and the subwoofer. The load capacity of the amplifier limits the number of speakers that you can use in the system.

GENESIS series 3 amplifiers are 2 Ω stable, the minimum amplifier load is 2 ohms.

MULTIMODE CONNECTION

This is an example of a typical multimode connetion with a front system and a subwoofer. 12 dB passive high- and low-pass filters are used in combination with the original filters used for the front system.
All speakers have an impedance of 4 ohms.

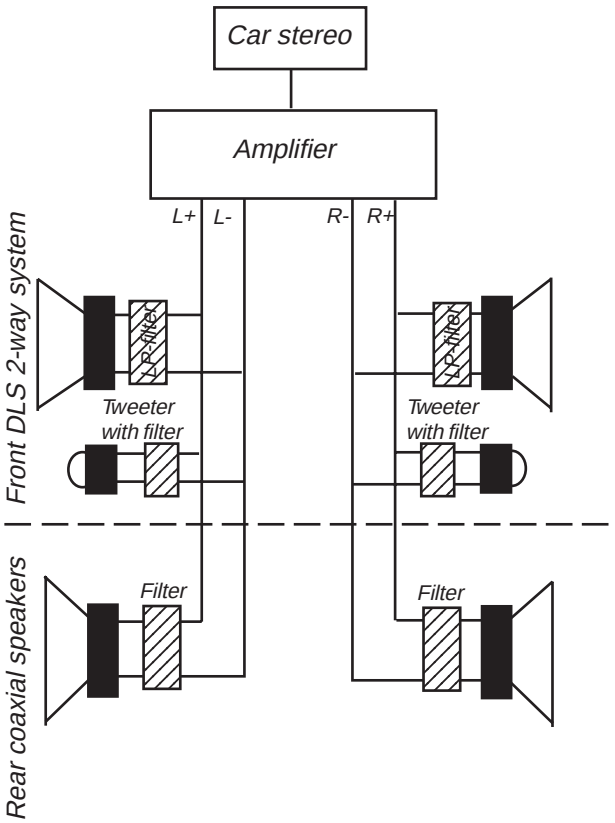


This connection can be used with all DLS and GENESIS amplifiers.

AMPLIFIER WIRING EXAMPLES

Example 1.
Basic wiring with one or two speaker pairs.

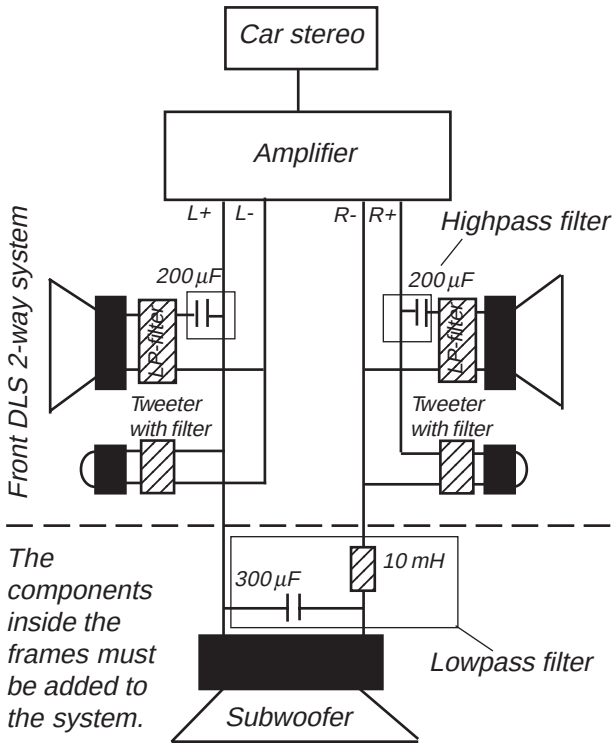
This example with one or two 4 ohm systems can be used with all DLS and GENESIS amplifier models. The amplifier load is 2 ohms when connected in parallel. Use 2/3-way systems or coaxial speakers. All speakers must have an impedance of 4 ohms.



Suitable for: All DLS and GENESIS models.
Speaker impedance: 4 ohm
Passive filters: Not needed except for the filters coming with the speaker kits.
Advantages: One amplifier can run both front and rear speaker systems.
Disadvantages: You can´t balance the sound levels between front/rear speakers. (It´s possible to use fixed resisors in series with the speakers to adjust the levels.)
Amplifier load: 2 ohms

Example 2.
System with a front system and a multimode connected subwoofer.

This system is similar to that on page 12. But here we use a 6 dB filter (200 µF capacitor) to the front system. With only one system and a subwoofer it´s sufficient with a 6 dB filter. All speakers must have an impedance of 4 ohms.

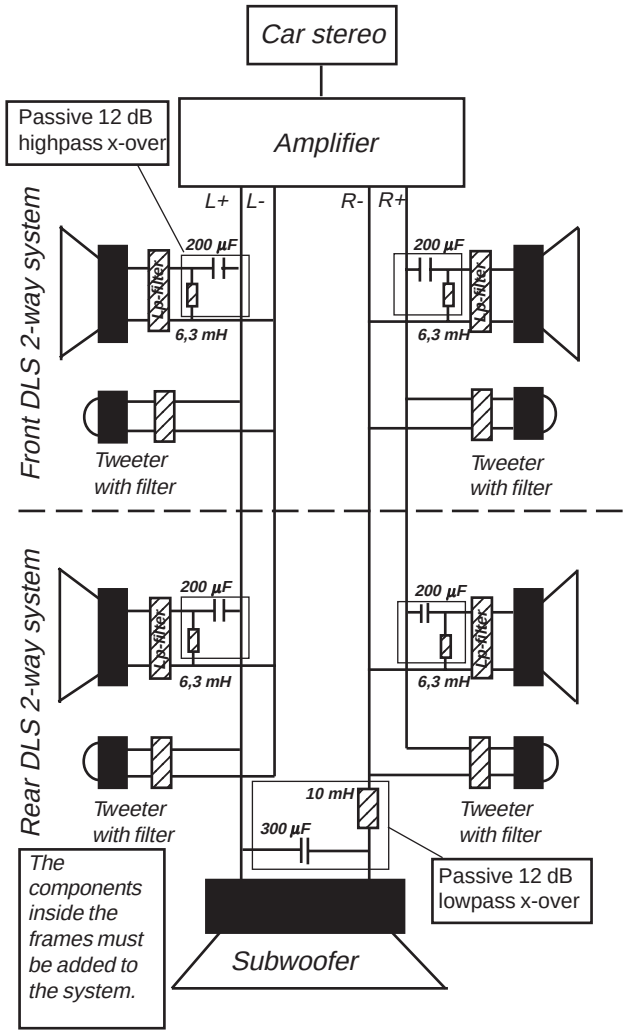


Suitable for: All DLS and GENESIS models.
Passive filters: To the sub: 12 dB low-pass filter with 300 µF capacitor + 10 mH coil giving 95 Hz x-over.
To the front system: 6 dB high-pass filter with 150 - 200 µF capacitor giving 180 Hz x-over. The original filters in the systems must also be used.
Capacitors must be of bipolar type.
The coil must have low resistance, 0,5 - 0,7 Ω.
Advantages: One amplifier can be used for the whole system.
Disadvantages: You can´t adjust the sound level to the subwoofer.
Alternatives: If you use two subs they must be of 8 ohms impedance connected in parallel to obtain a 4 ohm amplifier load.
Amplifier load: 2 ohms

NOTE! In multimode operation the connected subwoofers must never form an impedance lower than 4 ohms.

Example 3.
System with a front and a rear system, and a multimode connected sub.

This system can be used together with most GENESIS 2-channel amplifiers if 12 dB highpass cross-overs are used to both front and rear systems and subwoofer. Both front and rear speakers are 2-way systems. The impedance of the subwoofer is 4 ohms.

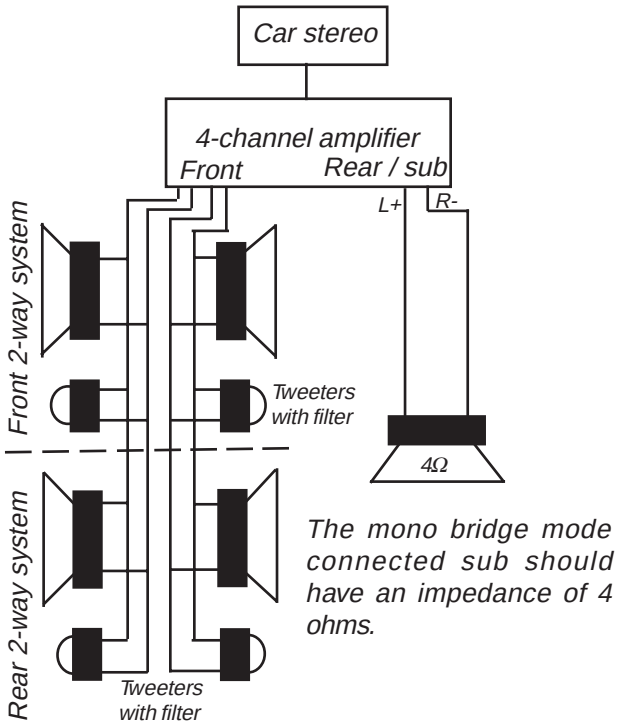


Suitable for: DLS and GENESIS 2-channel amplifiers.
Speaker impedance: 4 ohms for all.
Passive filters:
To the sub: 12 dB lowpassfilter with 300 µF capacitor + 10 mH coil giving 95 Hz x-over freq.
To front/rear systems: 12 dB highpass filter with capacitor 200 µF and 6,3 mH coil giving 140 Hz x-over frequency. The systems original filters must also be used.
Alternatives: If you use 2 subs they must be of 8 ohm impedance connected in parallel to 4 ohm.
Advantages: One amplifier for the whole system.
Disadvantages: You can´t vary the sound front/rear or the level to the subwoofer.
Amplifier load: 2 ohm

NOTE! The subwoofers must never form an impedance lower than 4 ohms.

Example 4.
System with a 4-channel amplifier, front and rear system and subwoofer.

In this example a front and a rear system are connected in parallel on FRONT. Two or three subwoofers are connected to REAR. The amplifiers built-in filters are used. Suitable for Q-100X, Q-200X, Four Channel and DLS DQ-200.



The mono bridge mode connected sub should have an impedance of 4 ohms.

The passive filters are not shown, but must naturally be used.

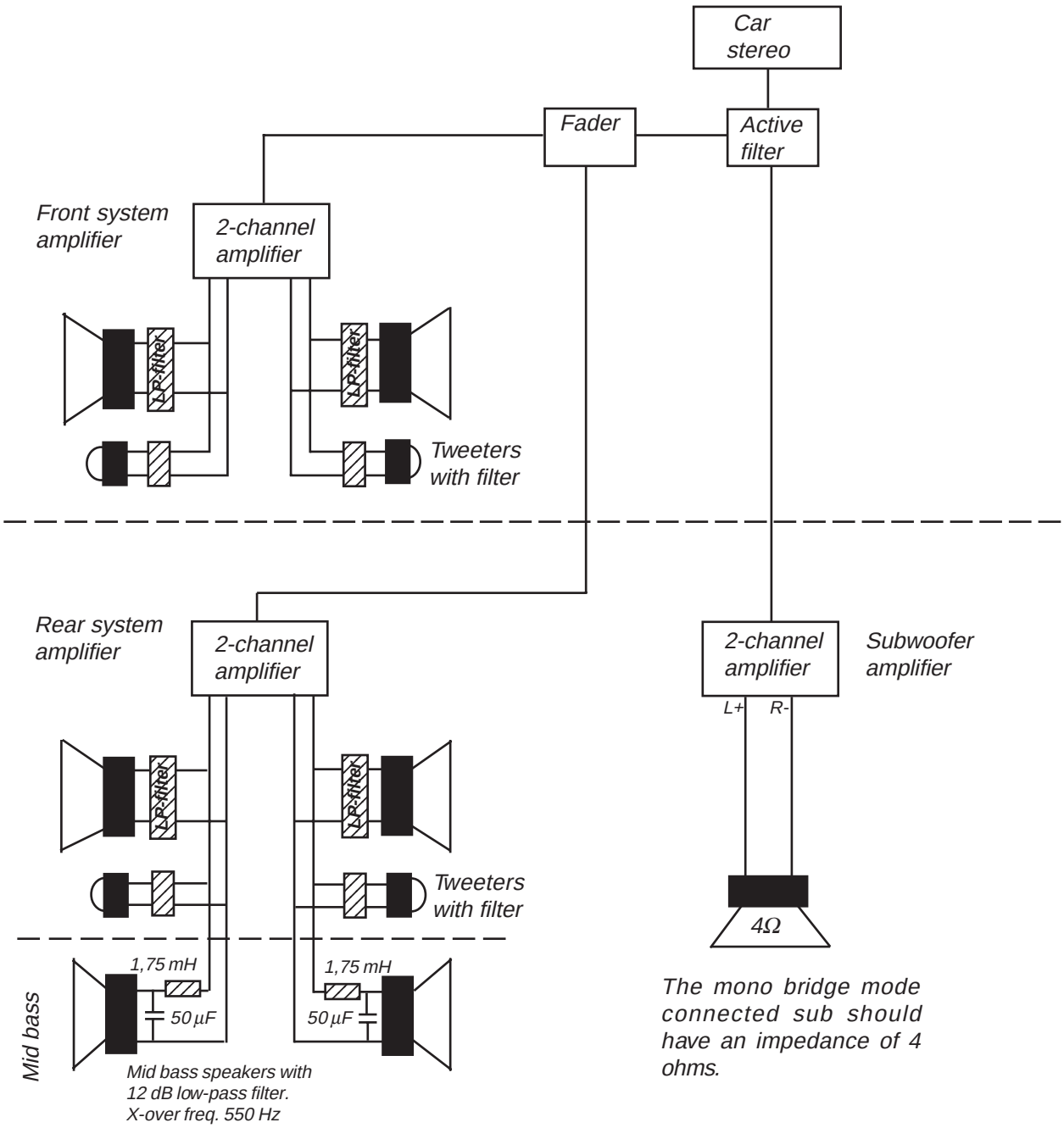
Suitable for: GENESIS and DLS 4-channel amplifiers
Filter: No passive filters needed. The amplifiers built-in filters are used.
Built-in filters: Adjust the built-in filters of the amplifiers according to the owners manual.
The speaker systems own filters are also used.
Alternatives: One or two systems can be connected in parallel to the FRONT output.
Mid-basses can be connected to the speaker output of the car stereo through a 12 dB low-pass filter with 550 Hz crossover. C = 50 µF, L = 1,75 mH.

Amplifier load in the example above: FRONT: 2 ohms
REAR: 2 ohms

NOTE! The subwoofers must never form an impedance lower than 4 ohms.

Example 5:
System with separate amplifiers for front and rear system with fader. Separate amplifier for the subwoofers.

This system with three amplifiers and a filter box gives you many possibilities to adjust and balance the sound in your car so that every speaker plays at the wanted level. This is an advantage compared to multimode connected systems. It´s also possible to use mid-bass speakers with a passive crossover.



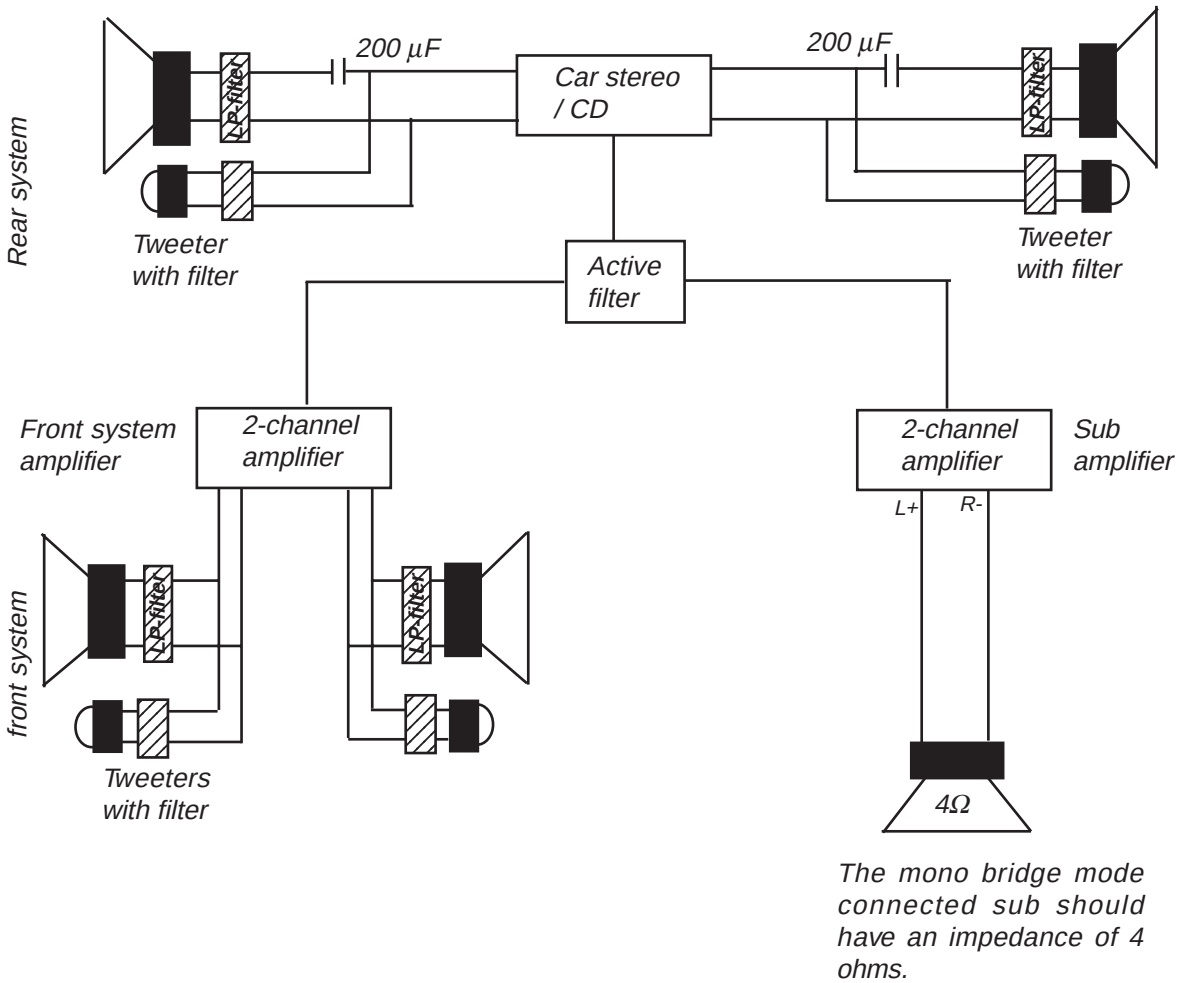
Suitable for: All DLS and GENESIS 2-channel amplifiers can be used in this example.
To DLS and GENESIS series 3 you can use the internal crossovers instead of the separate active filter.
The mid-bass speakers can be connected to either the front or the rear system.
Active filter: You can use DLS 2W1 to split the signal.
Amplifier load: front system 4 ohm
rear system with mid-subs: 2 ohm

NOTE! The subwoofers must never form an impedance lower than 4 ohms.

Example 6:

System with separate amplifiers, one for the front system and one for the subwoofers. The rear system is fed directly from the car stereo.

In this system the built-in amplifier of the car stereo is used for the front system through a 6 dB highpass-filter with 200 Hz x-over. An active filter splits the signal between the rear and the sub amplifiers.



The mono bridge mode connected sub should have an impedance of 4 ohms.

Suitable for: All DLS and GENESIS 2-channel amplifiers can be used in this example.
To DLS and GENESIS series 3 amplifiers you can use the internal filters instead of the Active filter.

Passive filters: To the rear system a 6 dB x-over (200 µF capacitor) with 200 Hz x-over frequency, 300 µF gives a x-over of 130 Hz, 150 µF gives 266 Hz.

Active filter: Use an active filter box to split the signal between front and sub system.

Disadvantages: There will be a great difference in sound quality between the rear system without external amplifier, and the front system using a separate amplifier.

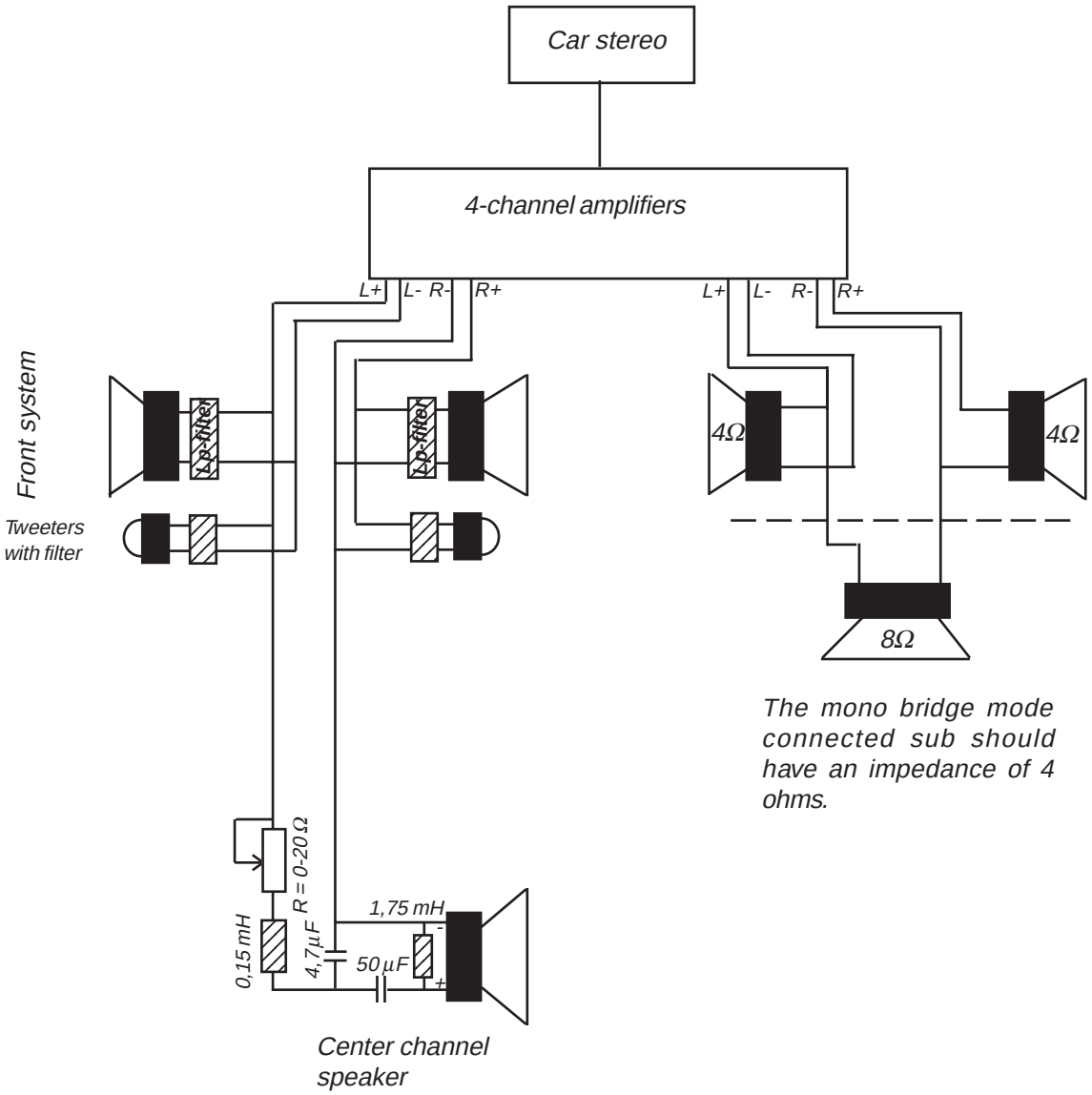
Amplifier load: Rear system: 4 ohms.

NOTE! The subwoofers must never form an impedance lower than 4 ohms.

Example 7:
System with a 4-channel amplifier, front and rear system, subwoofers and a center channel speaker.

In this system you can use DLS DQ/Ref 200, GENESIS Q-100X, Q-200X, Compact Four or Four Channel. All these amplifiers have built-in electronic crossovers.

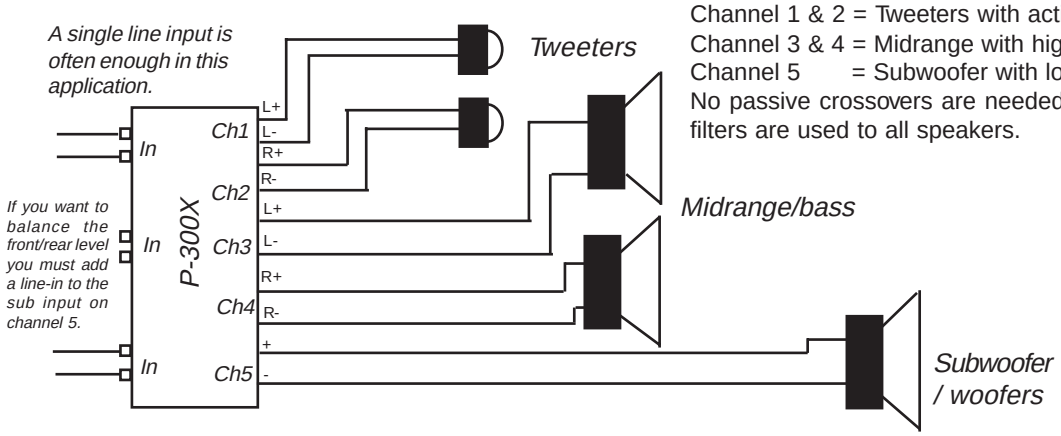
A center-channel speaker is connected i multimode. The center-channel level can be adjusted with a variable resistor.



Suitable for: All DLS and GENESIS 4-channel amplifiers.
Passive x-overs: A center channel speaker is connected in bridge mode. To adjust the level you need a variable resistor with 15 watts power handing capacity. A band-pass filter allows the speaker to reproduce frequencies between 550 to 6000 Hz.
Active filters: The built-in filters are used.
Amplifier load: FRONT: 1,3 ohms
REAR: 2 ohms in the example above.

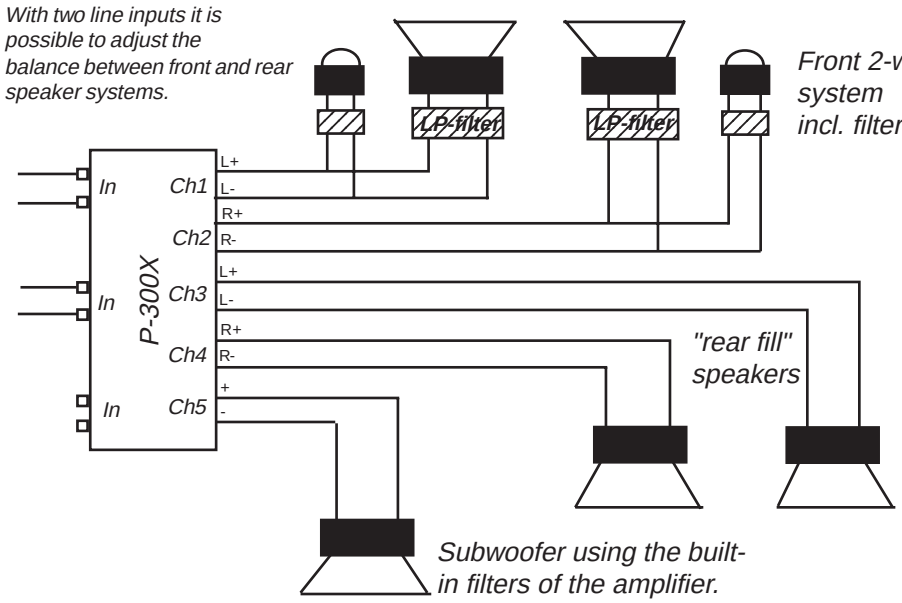
NOTE! The subwoofers must never form an impedance lower than 4 ohms.

Example 9:
System with P-300X, 5-channel amplifier with a front 2-way system with active crossover and a subwoofer.



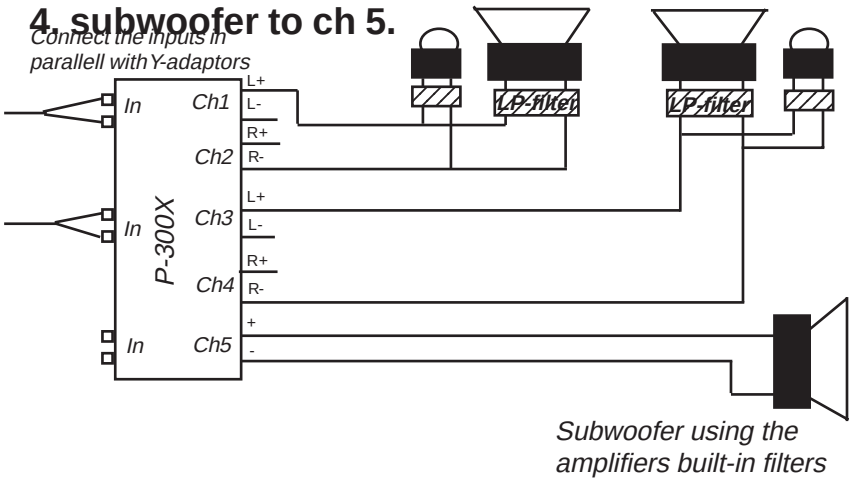
Channel 1 & 2 = Tweeters with active high-pass filter
Channel 3 & 4 = Midrange with high- and low-pass filter
Channel 5 = Subwoofer with low-pass filter
No passive crossovers are needed. The built-in active filters are used to all speakers.

Example 10:
System with P-300X, front system, "rear fill", and a subwoofer.



In this example the speakers own passive filters are used to the front system in combination with the built-in highpass filters on channel 1-2.
On channel 3-4 är "rear fill" speakers are connected. the amplifiers built-in filters are used.
The sub also uses the built-in filters.

Example 11:
System with P-300X. Front system connected in bridge mode to ch. 1 - 4, subwoofer to ch 5.

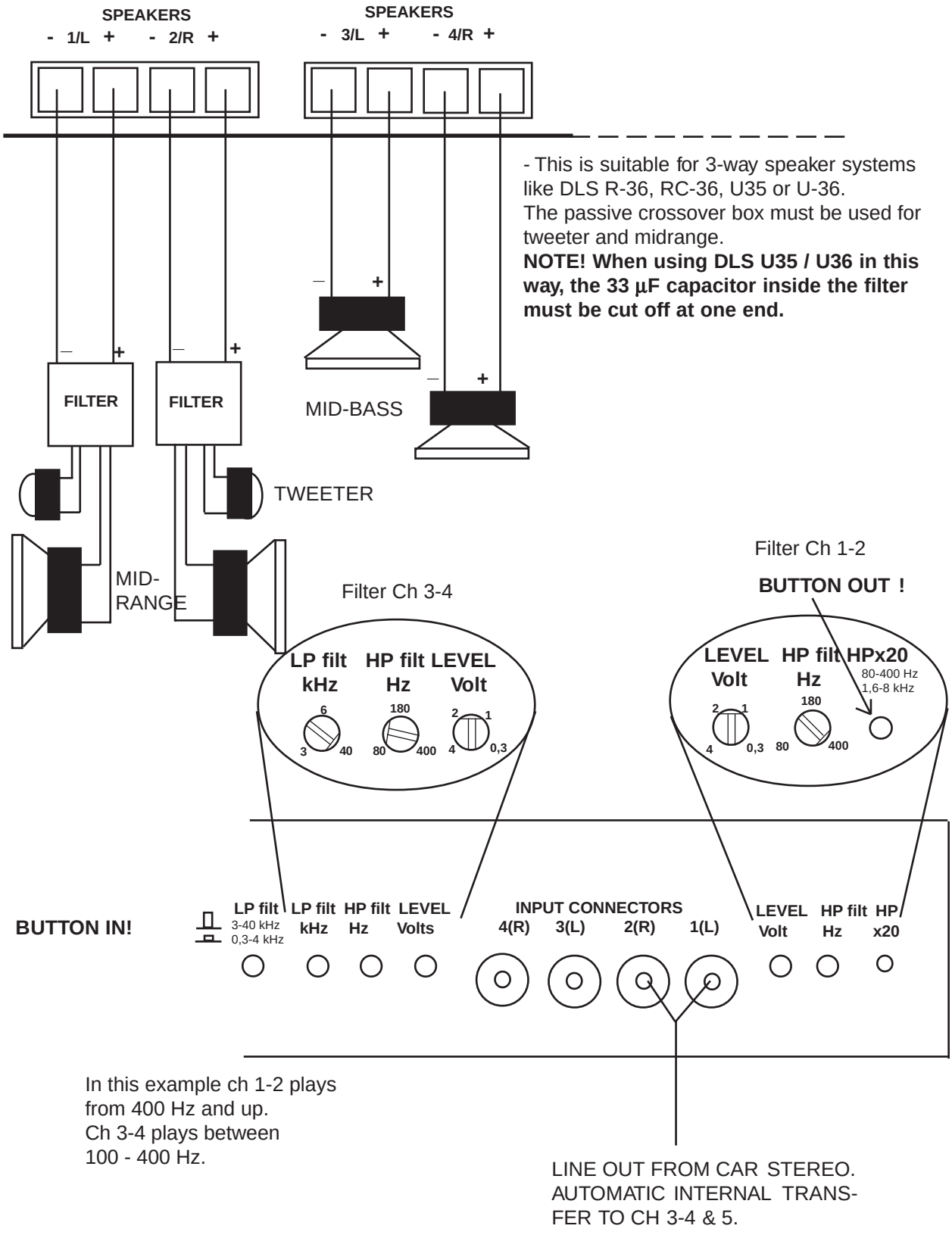


Front system connected in bridge mode to channel 1 - 4. The speakers own filters are used in combination with the built-in filters in the amplifier. (Adjust the ch 3-4 lowpass filter to 40 kHz x-over freq.) Subwoofer is using the ch 5 built-in filters.

Example 9:
System with GENESIS Five Channel, 5 channel amplifier with a front 3-way system with active x-over. (Not for P-300X).

All other wiring examples can be found in the owners manual for Five Channel.

The diagram shows the connection of a 3-way system, DLS U36 or similar, where tweeter and midrange speakers are connected to ch 1-2, midbasses to ch 3-4, and subwoofers to ch 5 (not shown). Passive crossover is used between tweeter and midrange.


SPEAKERS
- 1/L + - 2/R +
SPEAKERS
- 3/L + - 4/R +
- This is suitable for 3-way speaker systems like DLS R-36, RC-36, U35 or U-36.
The passive crossover box must be used for tweeter and midrange.
NOTE! When using DLS U35 / U36 in this way, the 33 µF capacitor inside the filter must be cut off at one end.
FILTER
FILTER
MID-BASS
TWEETER
MID-RANGE
Filter Ch 3-4
LP filt kHz
HP filt Hz
LEVEL Volt
Filter Ch 1-2
BUTTON OUT !
LEVEL Volt
HP filt Hz
HPx20
80-400 Hz
1,6-8 kHz
BUTTON IN!
LP filt 3-40 kHz 0,3-4 kHz
LP filt kHz
HP filt Hz
LEVEL Volts
INPUT CONNECTORS
4(R) 3(L) 2(R) 1(L)
LEVEL Volt
HP filt Hz
HP x20
In this example ch 1-2 plays from 400 Hz and up.
Ch 3-4 plays between 100 - 400 Hz.
LINE OUT FROM CAR STEREO. AUTOMATIC INTERNAL TRANS-FER TO CH 3-4 & 5.

WHY DO WE NEED SPEAKER BOXES?

A Hi-Fi speaker for home use is always mounted in a box to reproduce the best possible sound.
Traditional mounting in cars are in a door side or in the hat rack, this is a simple baffle mounting. You can of course achieve a better sound in your car by using suitable speaker boxes.
In a correct adapted box the sound is improved and the power handling capacity increases.
If you have a subwoofer in your trunk and a pair of "open air"- mounted speakers in the hat-rack the air pumping from the sub will effect the hat-rack speakers and make the cones move a little ruining the sound from them. This is one of many good reasons to use boxes also in your car.
Normally we use boxes for the subwoofer but also the rest of the speakers sounds better mounted in a suitable box.
We will now describe the different types of boxes normally used in a car.

SPEAKER BOXES, GENERAL

Build your boxes in a stable and air-tight material. The best is MDF-board, 19 mm, or particle board, 22 mm. Larger boxes must have braces inside to avoid resonance. The box must be completely air-tight. Use sealing compound in all joints, also in the hole for the cable. The size of the box are decided by the speaker data, but also the car type and music have an influence on the box size. Deep bass demands larger boxes than disco music.

SEALED BOXES

Sealed boxes are easy to build. The size is not critical, but it can´t be too small. The speaker data such as Fs, Qts, Vas and X-max decides the size of the box. Large speakers need larger boxes. Two speakers need a box of the double size etc. The box must be completely air-tight. Sealed boxes are normally used for door-panels or kick-panels. Most 4", 5,25" and 6,5" speakers can be used in sealed boxes.
A sealed box should be filled with acoustic wool up to 75 - 100%.
A sealed box has a lower efficiency than vented boxes but they can handle high power and are easy to build.
A subwoofer in a sealed box creates a tight bass suitable for the audiophiles listening to classical music, jazz and soft rock.
DLS subwoofers can be used in vented boxes as well as in sealed boxes.

If you use a 30-40 Hz subsonic highpass filter on the line input of your amplifier you will achieve a tight and well-defined bass in your bass-box. (All GENESIS series 3 amplifiers as well as the DLS amplifiers have a built-in subsonic filter.)

VENTED BOXES

A speaker in a vented box has higher efficiency (3 dB) and higher power handling capacity than in a sealed box. In a vented box the sound from the speaker and the port work together creating a higher sound level. The sound from the port must come out in the same phase as from the speaker otherwise the sound result is real bad.
The size of the box are decided by the speaker data just as in the sealed box. Also the car type and music type have an influence on the box size.
Often the size of the car decides the practical size of the box. A smaller box has a higher resonant frequency than the larger one. The size of the box should not be so large that the speaker plays below it´s own free air resonance (Fs), then it looses in power handling capacity.
The port in a vented box should be mounted on the same side of the box as the speaker. But sometimes this is impossible. The port opening inside the box must have a free area behind the port, to the wall behind, of at least the port diameter. There must also be a free area in front of the port. A large sub needs a larger port to avoid whistling sounds. Use ports with conical openings to avoid this. The port must also be fastened properly to avoid rattle.
As port material 3" or 4" PVC tubes are normally used. In a correct tuned box you should be able to feel the air pumping out from the port. At high volumes the air can blow out a burning match, if not the box and port are mismatched.

The port does not have to be fully inside the box as long as the area and length are correct. for example you can mount the port through a hat-rack. In a small box this can have an effect on the box tuning since the volume changes, avoid such small boxes.
Suitable port diameters for different speaker sizes:

8"	4 - 8 cm
10"	6 - 10 cm
12"	8 - 15 cm
15"	10 - 15 cm

Sometimes you need two or more ports in a box. You can convert from one to two or more ports as long as the total port area is the same.

All DLS subwoofers works well in vented boxes.

PORT LENGTH CALCULATION

The following formula can be used:

$$L(cm) = 17914 \times \frac{d^2}{Fc^2 \times Vb}$$

L = port length in cm
d = inner diameter of port in cm
Vb = net volume of the box in liter
Fc = Box resonant frequency in Hz

BANDPASS BOXES

In all bandpass boxes the speakers are hidden inside the box, all sound is coming out through the ports. There are different types of bandpass boxes and they have in common that they are a bit more difficult to build.

BOX DESCRIPTION

Mechanical orders for speaker boxes:

1:th order

Speaker in free air. Not in practical use, the speaker is acoustically shortened.

2:nd order

Speaker mounted on a baffle, normally called "open air".

This is not a box, just a way of mounting the speaker. For example in a hat-rack or behind the rear seat. Can create a good sound with the correct speaker parameters. The speaker should have a low resonant frequency.

3:rd order

Speaker mounted in a sealed box.

A sealed box is easy to build and calculate. It also has a high power handling capacity. On the other hand it has low efficiency and the box must be rather big to create a deep bass. With a rather small box and a 20-40 Hz subsonic filter you will get a box suitable for hard rock with a fast attack in the bass.

4:th order

Speaker mounted in a vented box, often called bass reflex box.

A vented box has a higher efficiency and a higher power handling capacity than the sealed box - but only if it´s correctly calculated with a suitable speaker element. Suitable for all kinds of music. The power handling capacity below the F-3db point is rather weak. It is important that the ports are correctly tuned, they must not be too small, then whistling sounds can occcour. With a wrong port the sound from the ports comes out phase reversed and causes a blurred sound.

5:th order

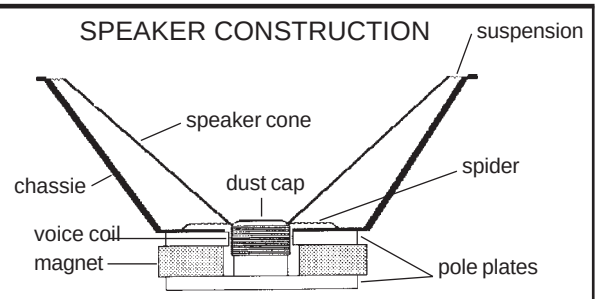
Speaker mounted in a sealed box, playing into a vented box.

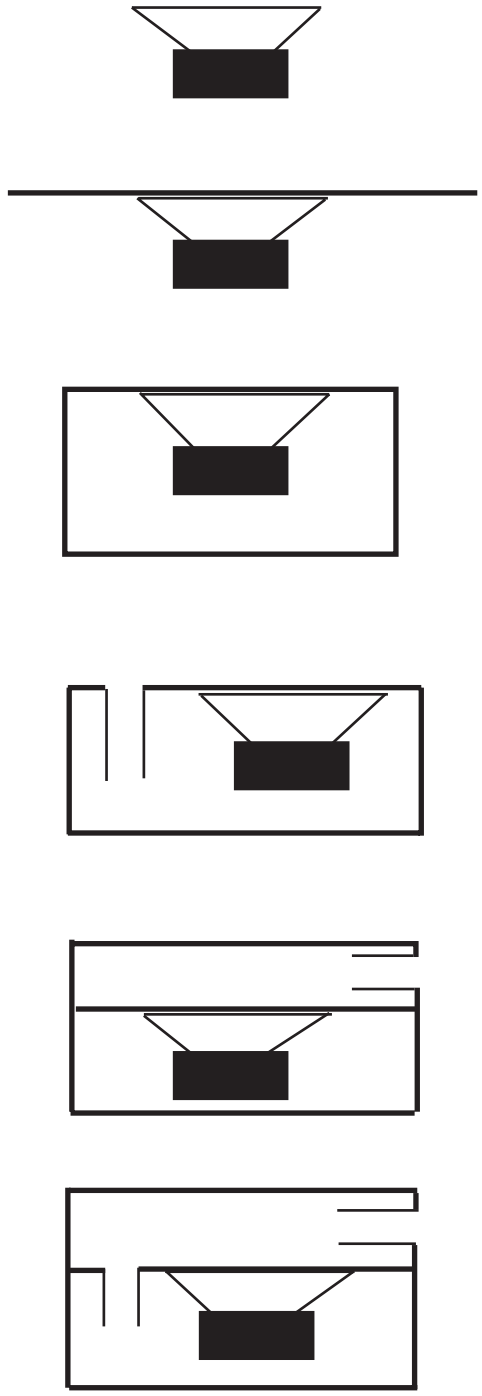
This type of box can play one octave only, but it has a high power capacity and gives a 3-5 dB raise at it´s tuned frequency. Suitable for disco and hard-rock music. Difficult to build and calculate and you can´t have speaker cloth in front of the ports.

6:th order

Speaker mounted in a vented box where both the speaker and the port is playing into another ported box.

This box is also difficult to calculate and build. Plays 2 octaves and gives a natural cut-off for higher frequencis with 12 dB/oct. which reduces the audible distortion. It has a high efficiency and power handling capacity. Low F-3dB and a top at the tuned frquencies. Small ports gives a whistling sound and you can´t have speaker cloth in front of the port. Build as isobaric it creates a powerful and distinct deep bass.





7:th order bandpass box

Speaker mounted in a vented box playing into another vented box. All ports going out.

What is valid for 6:th order boxes is also valid for 7:th order boxes. The difference is that this box gives a 6 - 10 dB peak at the tuned frequencies.

8:th order bandpass box

Speaker mounted in a vented box playing into another vented box with all ports playing into a third vented box.

This type of box becomes rather large but the port openings can be covered with cloth. It has like the 6:th and 7:th order boxes high efficiency and power handling capacity. It also gives a 6 - 10 dB peak at the tuned frequencies.

3-chamber bandpass boxes

Both 5:th order boxes and 7:th order boxes can be built as 3-chamber boxes with two speakers playing into a ported chamber.The picture shows a 5:th order 3-chamber box. In a 7:th order 3-chamber box all chambers have ports.

ISOBARIC BOXES

Two speakers mounted on the same axis and operating in the same phase and direction (push and pull).

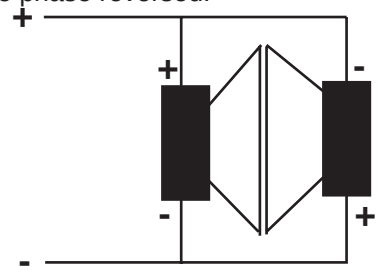
All box types can be built isobaric giving the following advantages and disadvantages.

Advantages: *Reduced box volume with the same F-3 dB*
Higher efficiency
Lower distortion

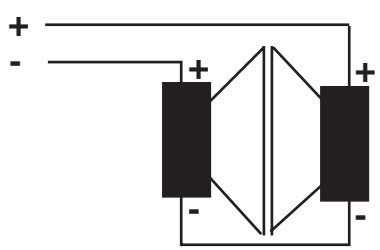
Disadvantages: *Difficult to build and calculate*
The speaker specifications changes (Qts and Vas)

Isobaric-connection:

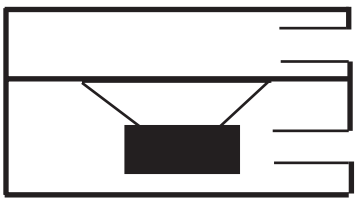
Isobaric speakers are connected with the inner sub in phase with the outer, but phase reversed as in the drawing below.
If both are in boxes the one in the smallest box should be phase reversed.

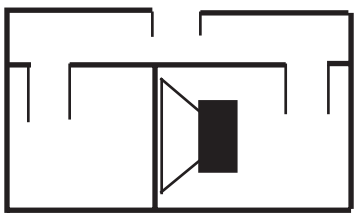


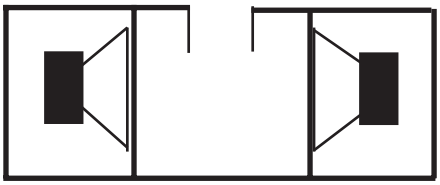
Speakers in parallel

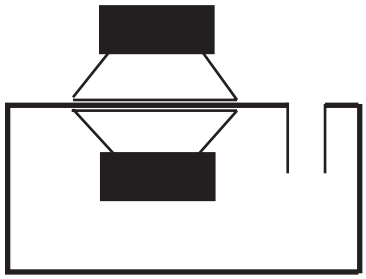


Speakers in series

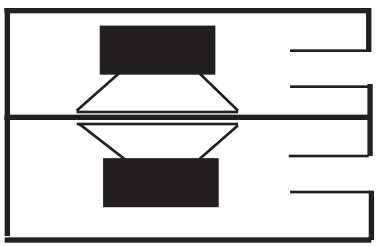








4:th order isobaric box



7:th order isobaric bandpass box

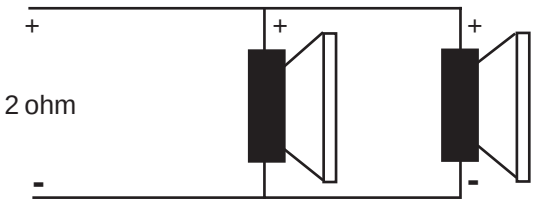
Use DLS BP-75 and BP-110 conical ports to avoid noice from the ports.

SPEAKER LOADS

Most car audio speakers have a 4 ohm impedance. DLS amplifiers can be loaded down to 2 ohm on each stereo channel.
In mono bridge mode operation the speaker load must never be less than 4 ohm. If you are using more than one driver they must be connected in a way so the impedance still is 4 ohm when connected to the amplifier. When you run the amplifier in mono bridge mode it sees a 4 ohm load as 2 ohm. On page 4 you find different speaker wiring examples.

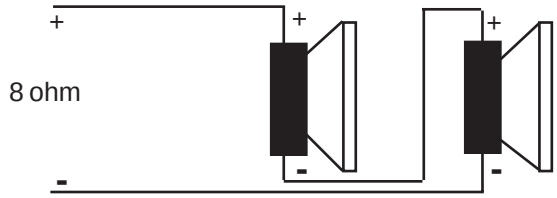
Don´t forget that the output power from a multimode connected amplifier is more than double the normal power. The speakers must be able to handle this power.

Two speakers in parallel



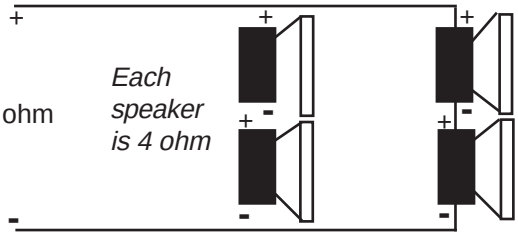
Only for stereo mode, not bridge mode.

Two speakers in series.

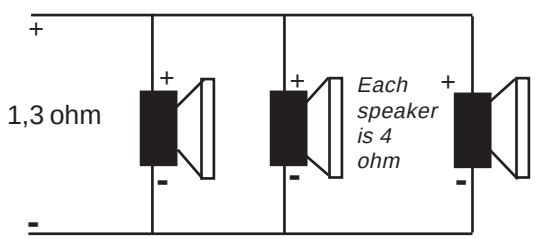


We don´t recommend this connection.

Four speakers in series/parallel to 4 ohm.



Three speakers in parallel



Only for Five Channel monokanal & Monoblock

SPEAKER CONNECTION

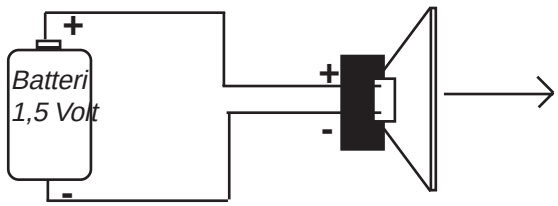
Always use high quality speaker cables such as **DLS SC 2x1,5, SC 2x2,5** or **SC 2x4.** Subwoofer connection requires 2 x 4 mm^2 cable.
Connect the speaker + (marked with + or a red dot) to the amplifier + terminal, and the speaker - to the amplifier -.
When fitting the cables to the amplifier terminals, remove only 10 mm of the insulation. Twist the wire strand together and insert the wire after loosening the terminal screw. Do not over tighten as this can cut the cable strands.

If you want an extra high class speaker cable choose any of the DLS SCP, SCK, SC 4x1 or SC 4x1,5 cables.

SPEAKER POLARITY CHECK.

All speakers in a car audio system should be connected in phase (the same polarity). All speaker cones must move in the same direction. Out of phase speakers will cause a lack of bass, and a poor stereo soundstage.

Checking polarity:
Hold the - connection of the speaker wire to the - terminal of a 1,5 Volt flashlight battery. Tap the + wire on to the + terminal of the battery, and observe the movement of the cone. The cone should move outwards when the wire touches the battery, and inwards when the battery is removed. If it is the other way around, the speaker has been connected backwards and it must be removed and connected correctly.
If your system also has a subwoofer connected through a passive 6 or 12 dB crossover, try to connect this with various polarity and judge what sounds best. The phase shift in passive crossovers sometimes makes it necessary to change polarity.



NOTE! You cant test tweeters in this way.

DLS Z-MATCH

If you have problems to match your speaker impedance to your amplifier we recommend the use of an impedance matching transformer.
DLS ZM1 is such a product. It´s a transformer with different taps. By connecting it in different ways you will get different impedance ratios.
For example it´s possible to connect four 4 ohm subs in series to 16 ohms, and still get a 4 ohm load on the amplifier.

Installing car sound can sometimes cause problems. If you are not satisfied with the sound you could have made something wrong.
Some typical problems are described below with hints for solving them.

1. Problem: Poor bass reproduction despite of a correctly designed bass box.

- Start with phase reversing the subwoofer to see if this helps.

- If you are using more than one subwoofer make sure they are connected in the same phase (polarity), if not most bass sound disappears. (The speaker cones are moving but will not create bass sound).

- If the bass reproduction is improved when opening the doors of your car the box is too large, The F-3dB point is too low. Make the box smaller.

- Standing waves can "kill" some frequencies. Try to change place for the box. You can also try to make the bass port shorter, this will increase the box resonant frequency.
  In some cases the area under the dashboard can work as a wave trap killing some low frequencies. Try to fill this area and tighten it.

- Also check the signal cable. If yuor subwoofer is connected in mono bridge mode and one of the leads are broken in a signal cable the sound becomes real bad.

- You must also have enough power, especially if you have a small sealed enclosure the power output should be at least 200 Watts RMS.

2. Problem: The real "kick" lacks in the bass sound.

- The box is not correctly build, or the box is not air tight.

- The sub amplifier does not get enough power, the power cables are too small, the ground connection bad, or some other things that is causing voltage drop at high power outputs.
  A cheap amplifier with unsufficient capacity in the DC-converter can give the same result.
  A good car battery with low inner resistance (OPTIMA) or a Power Cap of 0,5 Farad or more connected to the power lead will also improve the bass reproduction.

3. Problem: "Rumble" bass sound.

- The box tuning is too low, make the F-3dB higher with a smaller box.

- Connect a subsonic high-pass filter, 30 - 50 Hz, in series with the amplifier input.

- Use vented or sealed boxes. Avoid band-pass boxes, they are more difficult to build, and if theyare incorrectly designed they create a rumble bass sound.

4. Problem: Poor bass reproduction in a system without separate subwoofer.

- Is normally caused by incorrect speaker phasing. Make sure all woofer elements in the system are connected with the same polarity (phasing). Both front and rear speakers.
  This is easiest made with the use of a 1,5 Volt battery. Connect the battery + to the speaker + cable, and the - to the speaker - cable. All spea ker cones must move outwards when the battery is connected.

5. Problem: Interference sound from the alternator in systems with a separate amplifier.

- Is normally caused by incorrect grounding. Try to connect all units to the same ground point. It should be a place close to the amplifier where the paint is removed from the metal surface.

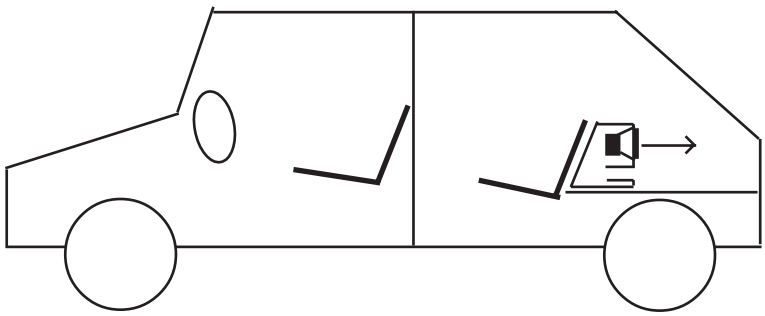
- Poor shielding on the signal cables, or a defective cable.

- The signal cable is placed close to the cars own cable wiring inducing interference into the signal cable.

- Any extra cable must not be laid in a ring, shorten the cable or lay it in zig-zag instead.

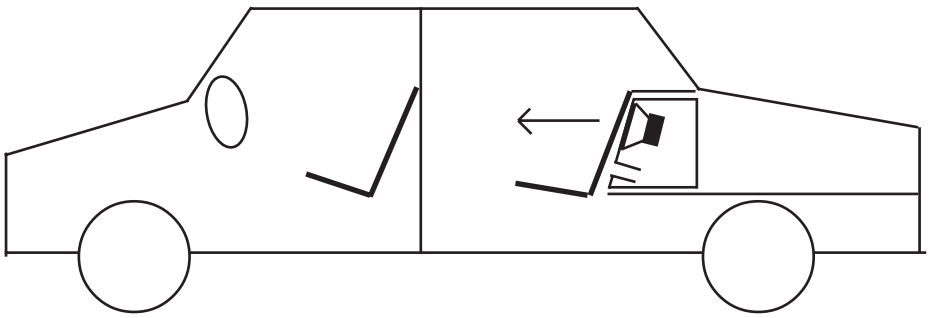
BASS BOXES IN DIFFERENT TYPES OF CARS

1. SMALL CARS LIKE VW GOLF, OPEL KADETT, PEUGOT 205 AND SIMILAR



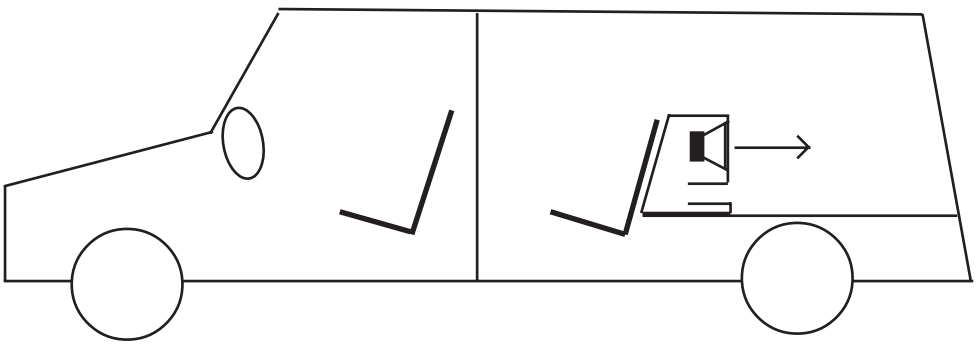
In this car type the bass box should be mounted with both speaker and port directed backwards. Alternatively booth speaker and port can be directed upwards. This way of mounting is valid also for half-combi car types.

2. SEDAN CARS LIKE VOLVO 240/740/940/850, SAAB 9000 AND SIMILAR



In this car type with the passanger compartment separated from the luggage compartment the bass box should be mounted with booth speaker and port directed towards the rear seat. In some cars there is an opening in the middle of the rear seat for loading skis etc. You can place the box behind this opening and direct speaker or port through this opening. There must be some free space in front of the port, (between the rear seat and the port opening)
Don´t put the port through the hat rack if the speaker is directed towards the rear seat, this will give a poor sound. Alternatively you can mount both speakers and port in the hat rack with a box under it, but this requires more changes of the car original interior.

3. LARGE CARS, STATION WAGONS LIKE VOLVO 245 / 745 AND SIMILAR.



In this type of cars the best sound is achieved with the bass box mounted behind the rear seat with booth speaker and port directed backwards. Alternatively you can put the bass box on one side of the luggage compartment.

DLS-BOX COMPUTER PROGRAM

A speaker box can be calculated either by hand or with the help of a computer program. DLS-BOX 2000 is a program that easily helps you design your own box to your DLS speakers.
You choose speaker, box type, car-type and music type and the program calculates the correct box volume. The program is developed in cooperation with Backes ljudbyggeri in Ekerö. "Dr. Backe" has many years of box building experince and assures you that if only the parameters are correct the program will give you the best speaker box.
Read his box building advices below.

SOME ADVICES FROM DR. "BACKE"

When building a bass box the following are very important:
The box must be very steady and completely air-tight. Use 22 mm particle board or 19 mm MDF-board. The particle board has a self resonant frequency of 14 Hz while the MDF has a resonant frequency of approx. 400 Hz. Its important to stabilize the box inside with some braces, especially the boxes made of MDF could cause "PLONK"-sounds if it´s not sufficiently braced.
If you are using a milling machine its better to use MDF-board since particle board wears the cutter edge. After cutting all pieces to the box you attach glue in all joints and screws every 10 cm. Use more screws if the edge cutting isn´t perfect.
The length of the screws should be a little more than double the board thickness. Tighten all joints with extra silicon sealing compound.
If you build a bandpass box let one side be removable to make it easier to change speaker.
Use sealing strips in the joint. The length of the screws should be 3 times the board thickness. Mount them 6 cm apart.
Use conical bass ports for best result. (DLS BP-75 or BP-110).
If the ports are too long for the box you can add a bend to it. Either cut the tube and glue it together in angle, or use factory made tube bends.
It´s easier to use the factory made ones. The total length must be the same as for a straight tube. Make the measure in the center of the tube.
The port opening inside the box must not be closer to a box wall than the ports own diameter. Otherwise it will have negative effects on the airflow.

Most boxes should be damped inside with syntetic (acoustic) wool (do not use any rockwool types). Attach the damping material on the wall opposite from the speaker and port. A sealed box should be filled up to 70-100% with acoustic wool.
In a vented box the speaker and port should be mounted on the same side, otherwise a fade-out of some frequencies can occour. In most car-types, except for SEDAN cars, the speaker and port should be directed backwards for best result.
If you plan **not** to cover your box with felth cloth or imitation leather you should also tighten behind the speaker element before mounting it in the box. It must be absolutely air-tigth.
If you build an isobaric-box use through screws with nuts and washers to fasten the speakers. Also tighten the screw holes with sealing compound. Be sure to connect the isobaric speaker pair in the correct way.
You can´t use felt cloth or similar in front of the ports, especially in band-pass boxes.
Good luck with your box project!

BOX EXAMPLES

On the following pages you will find examples on suitable boxes for DLS speakers and subwoofers.
If you follow the advices in this handbook we are sure you achieve a good car sound.

Good luck !

If you have any questions you are always welcome to call us on DLS in Sweden. We will do our best to assist you.

Telephone: +46 31 84 00 60
Fax: +46 31 84 40 21
E-mail: info@dls.se

Download the DLS-BOX 2000 from ourWEB-site www.dls.se or www.audiophiles.nu

BASS BOXES FOR OLDER SUBS

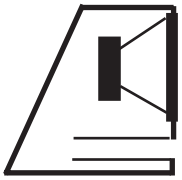
Some bass box examples for older DLS subwoofers

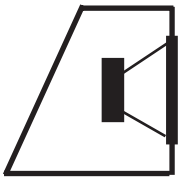
SPEAKER & TYPE OF BOX:	CARTYPE: SEDAN/SMALL	STATION WAGON
DLS 5508:		
Music: Normal		
Vented box	23 liters	26 liters
Port	3" x 22 cm	3" x 21 cm
DLS 5508A:		
Music: Normal		
Vented box	20 liters	23 liters
Port	3" x 22 cm	3" x 21 cm
DLS 5310 / 5510:		
Music: Normal		
Sealed box	35 liters	41 liters
Vented box	35 liters	39 liters
Port, vented box	3" x 14 cm	3" x 14 cm
DLS 5310A:		
Music: Normal		
Vented box	37 liters	43 liters
Port	3" x 9 cm	3" x 8 cm
DLS 5310B:		
Music: Normal		
Vented box	39 liters	45 liters
Port	3" x 12 cm	3" x 11 cm
DLS 5512A:		
Music: Normal		
Vented box	68 liters	78 liters
Port	4" x 10 cm	4" x 9 cm
DLS 5612:		
Music: Normal		
Vented box	54 liters	63 liters
Port	4" x 13 cm	4" x 12 cm
DLS 5615:		
Music: Normal		
Vented box	81 liters	93 liters
Port	4" x 16 cm	4" x 15 cm

If you have any older type of DLS subwoofer, please contact us and we will help you calculate a suitable box.

SUBWOOFER ENCLOSURES FOR NEW MODELS

On the following pages you will find suitable enclosure volumes for all DLS subwoofers. You find actual models as well as models no longer in production.
All vloumes and ports are calculated by the use of DLS-box 2000. In all calculations are both the displacement for the speaker driver and the port included in the given volume. You don´t have to add any volume to the size given in the examples. The easiest way to calculate the box volume is just to take the height x width x depth in dm, and the result of this calculation is the volume in liters. But it must be the inside measures of the box.
The examples shown is for sealed and vented boxes including one subwoofer. For other examples we recommend the use of DLS-box 2000. It can be downloaded free from our web-site www.dls.se.





W 108 / 108C

Vented box

The port length in all examples is for a 3” (75 mm) outer diameter.

Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hardrock	18	23	17	23	19	22	19	22
Disco	20	21	20	21	21	21	22	20
Normal	23	20	23	20	25	20	26	20
Deep bass	26	20	26	19	28	19	30	18

Sealed box

Suitable for hard rock and disco music

Car type:	Small car	Sedan	Combi type	Station wagon
Music type:	vol liter	vol liter	vol liter	vol liter
Hard rock	17	17	18	19
Disco	20	19	21	22
Normal	23	22	24	26

W 110 / 110C

Vented box

The port length in all examples is for a 3” (75 mm) outer diameter.

Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hard rock	25	16	24	16	26	15	28	15
Disco	28	15	28	15	30	14	32	14
Normal	32	14	32	14	35	13	37	13
Deep bass	36	13	36	14	39	13	42	13

Sealed box

Suitable for hard rock and disco music

Car type:	Small car	Sedan	Combi type	Station wagon
Music type:	vol liter	vol liter	vol liter	vol liter
Hard rock	25	25	26	28
Disco	28	28	30	32
Normal	32	32	35	37

W 112 / 112C

Basreflexlåda

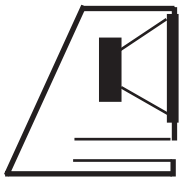
The port length in all examples is for a 4” (110 mm) outer diameter.

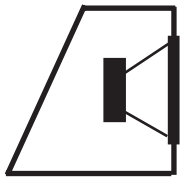
Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hard rock	37	25	36	25	39	24	40	24
Disco	41	24	41	24	44	24	46	23
Normal	47	23	46	22	50	22	53	22
Deep bass	52	21	52	22	56	21	60	20

Sealed box

Suitable for hard rock and disco music

Car type:	Small car	Sedan	Combi type	Station wagon
Music type:	vol liter	vol liter	vol liter	vol liter
Hard rock	36	35	38	40
Disco	40	40	43	45
Normal	46	45	49	52





W 108B

Vented box

The port length in all examples is for a 3” (75 mm) outer diameter.

Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hard rock	16	25	16	26	17	25	18	25
Disco	19	24	18	24	20	23	21	23
Normal	21	23	21	23	23	22	24	22
Deep bass	24	22	24	21	26	21	28	21

Sealed box

Suitable for hard rock and disco music

Car type:	Small car	Sedan	Combi type	Station wagon
Music type:	vol liter	vol liter	vol liter	vol liter
Hard rock	16	15	17	17
Disco	18	18	19	20

W 110B

Vented box

The port length in all examples is for a 3” (75 mm) outer diameter.

Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hard rock	26	16	26	16	28	15	29	15
Disco	30	16	30	15	32	15	34	14
Normal	35	15	34	15	37	14	40	14
Deep bass	39	13	38	14	42	14	45	13

Sealed box

Suitable for hard rock and disco music

Car type:	Small car	Sedan	Combi type	Station wagon
Music type:	vol liter	vol liter	vol liter	vol liter
Hard rock	27	26	28	30
Disco	30	30	32	34

W 112B

Vented box

The port length in all examples is for a 4” (110 mm) outer diameter.

Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hard rock	39	26	39	25	42	25	44	24
Disco	45	25	44	25	47	24	50	23
Normal	51	23	50	24	54	23	57	22
Deep bass	57	22	56	22	61	21	65	21

Sealed box

Suitable for hard rock and disco music

Car type:	Small car	Sedan	Combi type	Station wagon
Music type:	vol liter	vol liter	vol liter	vol liter
Hard rock	38	38	41	43
Disco	44	43	43	49

ULTIMATE UW10

Vented box

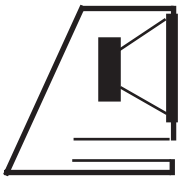
The port length in all examples is for a 3” (75 mm) outer diameter.

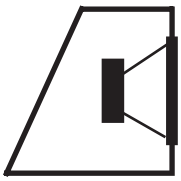
Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hard rock	20	22	19	23	21	22	22	22
Disco	22	20	22	21	24	20	25	20
Normal	26	20	26	21	28	20	29	19
Deep bass	29	19	29	19	31	19	33	19

Sealed box

Suitable for hard rock and disco music

Car type:	Small car	Sedan	Combi type	Station wagon
Music type:	vol liter	vol liter	vol liter	vol liter
Hard rock	19	19	20	21
Disco	22	22	23	45





W 310

Vented box

The port length in all examples is for a 3” (75 mm) outer diameter.

Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hard rock	23	19	22	19	24	19	25	18
Disco	26	19	25	18	27	18	29	17
Normal	30	17	29	18	32	17	34	17
Deep bass	34	17	33	16	36	16	38	16

Sealed box

Suitable for hard rock and disco music

Car type:	Small car	Sedan	Combi type	Station wagon
Music type:	vol liter	vol liter	vol liter	vol liter
Hard rock	22	22	24	25
Disco	26	25	27	29

W 312

Vented box

The port length in all examples is for a 4” (110 mm) outer diameter.

Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hard rock	36	29	36	29	38	28	40	28
Disco	41	27	40	28	43	27	45	26
Normal	47	27	46	26	50	26	53	25
Deep bass	52	25	51	25	56	24	59	24

Sealed box

Suitable for hard rock and disco music

Car type:	Small car	Sedan	Combi type	Station wagon
Music type:	vol liter	vol liter	vol liter	vol liter
Hard rock	35	34	37	39
Disco	39	39	42	44

W 310B

Vented box

The port length in all examples is for a 3” (75 mm) outer diameter.

Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hard rock	19	27	19	27	20	26	21	26
Disco	22	25	21	25	23	24	24	24
Normal	25	24	25	23	27	22	28	22
Deep bass	28	22	28	23	31	22	33	21

Sealed box

Suitable for hard rock and disco music

Car type:	Small car	Sedan	Combi type	Station wagon
Music type:	vol liter	vol liter	vol liter	vol liter
Hard rock	18	18	19	20
Disco	21	21	22	24

W 312B

Vented box

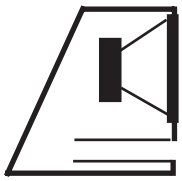
The port length in all examples is for a 4” (110 mm) outer diameter.

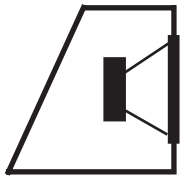
Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hard rock	35	32	34	33	37	32	38	31
Disco	39	30	39	31	42	30	44	29
Normal	45	29	44	29	48	28	50	28
Deep bass	50	28	49	28	54	27	57	27

Sealed box

Suitable for hard rock and disco music

Car type:	Small car	Sedan	Combi type	Station wagon
Music type:	vol liter	vol liter	vol liter	vol liter
Hard rock	33	33	35	37
Disco	37	37	40	42





W 510C

Vented box

The port length in all examples is for a 3” (75 mm) outer diameter.

Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hard rock	23	25	22	24	24	24	25	23
Disco	26	24	26	23	27	22	29	22
Normal	30	22	30	23	32	22	34	20
Deep bass	34	20	34	21	37	20	39	20

Sealed box

Suitable for hard rock and disco music

Car type:	Small car	Sedan	Combi type	Station wagon
Music type:	vol liter	vol liter	vol liter	vol liter
Hard rock	22	22	23	25
Disco	25	25	27	28

W 512C

Vented box

The port length in all examples is for a 4” (110 mm) outer diameter.

Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hard rock	35	21	34	21	37	21	39	22
Disco	39	22	39	22	42	23	44	22
Normal	45	21	45	22	48	21	51	20
Deep bass	51	22	50	21	55	20	58	21

Sealed box

Suitable for hard rock and disco music

Car type:	Small car	Sedan	Combi type	Station wagon
Music type:	vol liter	vol liter	vol liter	vol liter
Hard rock	34	34	36	38
Disco	39	38	41	43

DLS X12

Vented box

The port length in all examples is for a 3” (75 mm) outer diameter.

Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hard rock	26	19	26	19	28	18	29	18
Disco	30	18	29	18	32	18	33	17
Normal	34	17	34	17	36	16	38	16
Deep bass	38	16	38	16	41	16	44	16

Sealed box

Suitable for hard rock and disco music

Car type:	Small car	Sedan	Combi type	Station wagon
Music type:	vol liter	vol liter	vol liter	vol liter
Hard rock	26	26	28	29
Disco	30	29	31	33

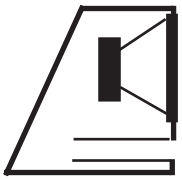
A 4 ” port would be to prefer, but the port length is 30-40 cm, so we use a 3” port in the example above.
Below is examples with a 4" port.

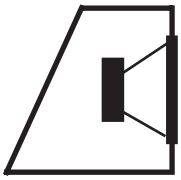
DLS X12

Vented box

The port length in all examples is for a 4” (110 mm) outer diameter.

Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hard rock	29	42	29	41	30	39	31	39
Disco	32	39	32	38	34	38	35	36
Normal	37	37	36	37	39	36	41	35
Deep bass	40	35	40	34	43	34	46	34





W 610

Vented box

The port length in all examples is for a 3” (75 mm) outer diameter.

Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hard rock	19	28	19	29	20	28	21	26
Disco	21	26	21	27	23	26	24	26
Normal	25	24	25	25	27	24	28	24
Deep bass	28	24	28	24	30	23	32	23

Sealed box

Suitable for hard rock and disco music

Car type:	Small car	Sedan	Combi type	Station wagon
Music type:	vol liter	vol liter	vol liter	vol liter
Hard rock	18	18	19	20
Disco	21	21	22	23

W 612

Vented box

The port length in all examples is for a 3” (75 mm) outer diameter.

Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hard rock	26	22	26	23	27	22	29	22
Disco	30	21	29	21	32	21	33	21
Normal	35	20	34	20	37	19	39	19
Deep bass	39	19	38	19	42	19	45	17

Sealed box

Suitable for hard rock and disco music

Car type:	Small car	Sedan	Combi type	Station wagon
Music type:	vol liter	vol liter	vol liter	vol liter
Hardrock	26	25	27	28
Disco	29	29	31	33

A 4 ” port would be better, but the port length is 40-50 cm, so we use a 3” port in these examples.

W 710

Vented box

The port length in all examples is for a 3” (75 mm) outer diameter.

Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hard rock	19	28	19	29	20	28	21	28
Disco	22	28	21	27	23	27	24	26
Normal	25	26	25	26	27	25	28	25
Deep bass	28	25	28	24	31	24	32	23

Sealed box

Suitable for hard rock and disco music

Car type:	Small car	Sedan	Combi type	Station wagon
Music type:	vol liter	vol liter	vol liter	vol liter
Hard rock	18	18	19	20
Disco	21	21	22	23

W 712

Vented box

The port length in all examples is for a 3” (75 mm) outer diameter.

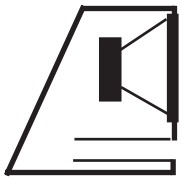
Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hardrock	26	22	26	22	28	22	29	22
Disco	30	21	30	21	32	20	34	20
Normal	35	19	34	20	37	19	40	19
Deep bass	40	19	39	19	43	18	45	17

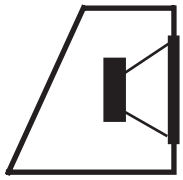
Sealed box

Suitable for hard rock and disco music

Car type:	Small car	Sedan	Combi type	Station wagon
Music type:	vol liter	vol liter	vol liter	vol liter
Hard rock	26	26	27	29
Disco	30	29	32	33

A 4 ” port would be better, but the port length is 40-50 cm, so we use a 3” port in these examples.





MW 10

Vented box

The port length in all examples is for a 3” (75 mm) outer diameter.

Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hard rock	16	34	16	33	17	33	18	32
Disco	19	32	18	32	20	31	21	31
Normal	22	29	21	30	23	29	24	28
Deep bass	24	28	24	29	26	27	28	27

Sealed box

Suitable for hard rock and disco music

Biltyp:	Golf	Sedan	Halv-kombi	Kombi
Musiktyp:	volym liter	volym liter	volym liter	volym liter
Hard rock	15	15	16	17
Disco	18	17	19	20

MW 12

Vented box

The port length in all examples is for a 3” (75 mm) outer diameter.

Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hard rock	24	22	24	22	26	22	27	21
Disco	28	22	28	21	30	20	31	20
Normal	32	20	32	20	35	20	37	18
Deep bass	37	18	36	19	39	18	42	18

Sealed box

Suitable for hard rock and disco music

Biltyp:	Golf	Sedan	Halv-kombi	Kombi
Musiktyp:	volym liter	volym liter	volym liter	volym liter
Hard rock	24	24	25	27
Disco	28	27	29	31

A 4 ” port would be better, but the port length is 40-50 cm, so we use a 3” port in these examples.

MW 110

Vented box

The port length in all examples is for a 3” (75 mm) outer diameter.

Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hard rock	17	30	17	30	18	29	19	28
Disco	19	29	19	29	20	28	21	27
Normal	22	27	22	27	24	26	25	26
Deep bass	25	26	25	26	27	25	29	25

Sealed box

Suitable for hard rock and disco music

Biltyp:	Golf	Sedan	Halv-kombi	Kombi
Musiktyp:	volym liter	volym liter	volym liter	volym liter
Hard rock	16	16	17	18
Disco	18	18	20	21

MW 112

Vented box

The port length in all examples is for a 3” (75 mm) outer diameter.

Car type:	Small car		Sedan		Combi type		Station wagon	
Music type:	vol liter	port cm	vol liter	port cm	vol liter	port cm	vol liter	port cm
Hard rock	24	23	24	23	25	22	27	22
Disco	28	22	27	31	29	22	31	20
Normal	32	21	31	21	34	20	36	20
Deep bass	36	20	35	19	39	19	41	18

Sealed box

Suitable for hard rock and disco music

Biltyp:	Golf	Sedan	Halv-kombi	Kombi
Musiktyp:	volym liter	volym liter	volym liter	volym liter
Hard rock	24	23	25	26
Disco	27	27	29	30

A 4 ” port would be better, but the port length is 40-50 cm, so we use a 3” port in these examples.

TABLE 1:

Shows the relation between power increase and SPL measured 1 mtr in front of the speaker at three different speaker sensitivities.

SPL in dB

Input power (W)	1	2	3	4	5	10	15	20	50	100	200	500	1k	2k	5k
Speaker sens-itivity in dB	88	91 dB			95 dB		100 dB		105 dB		110 dB	115 dB		120 db	125 dB
	95	98 dB			102 dB		107 dB		112 dB		117 dB	122 dB		127 dB	
	98	101 dB			105 dB		110 dB		115 dB		120 dB	125 dB		130 dB	

A speaker with a sensitivity of 88 dB gives a SPL of 88 dB with an input of 1 Watt. If the input power is increased to 2 Watts the SPL will be 91 dB etc. Duoble power will increase the SPL with 3 dB.

TABLE 2:

Shows how the inner resistance (impedance) of a coil changes in relation to the frequency.

	Frequency in Hz														
mH	25	50	75	100	120	200	400	800	1k	1,2k	2k	4k	8k	10k	12k
0,05												1,3	2,5	3,1	3,8
0,1		**Resistance in ohm**									1,3	2,5	5,0	6,3	7,5
0,2									1,3	1,5	2,5	5,0	10,0	12,6	15,1
0,3								1,5	1,9	2,3	3,8	7,5	15,1	18,8	22,6
0,5							1,3	2,5	3,1	3,8	6,3	12,6	25,1	31,4	37,7
1						1,3	2,5	5,0	6,3	7,5	12,6	25,1	50,2	62,8	75,4
2				1,2	1,5	2,5	5,0	10,0	12,6	15,1	25,1	50,2	100,0		
3			1,4	1,9	2,3	3,8	7,5	15,1	18,8	22,6	37,7	62,8			
5		1,6	2,4	3,1	3,8	6,3	12,6	25,1	31,4	37,7	62,8				
10	1,6	3,1	4,7	6,3	7,5	12,6	25,1	50,2	62,8	75,4					
20	3,1	6,3	9,4	12,6	15,1	25,1	50,2								

For example a coil with 10 mH inductance, often used as lowpass filter for subwoofers, has an inner resistance (impedance) of 1,6 ohms at 25 Hz increasing to 6,3 ohms at 100 Hz, and 62,8 ohms at 1 kHz.

TABLE 3:

Shows how the inner resistance (impedance) of a capacitor changes in relation to the frequency.

µF	12 kHz	10 kHz	8 kHz	6 kHz	4 kHz	3 kHz	2 kHz	1 kHz	800 Hz	700 Hz	600 Hz	500 Hz	400 Hz	300 Hz	200 Hz	120 Hz	80 Hz	60 Hz
0,22	60	72	90	120														
0,33	40	48	60	80	120													
0,47	28	34	42	56	85	113							**Resistance in ohm**					
0,68	19	23	29	39	58	78	117											
1	13	16	20	27	40	53	80											
2,2	6	7	9	12	18	24	36	72	90	100	120							
3,3	4	5	6	8	12	16	24	48	60	69	80	96						
4,7	3	4	6	8	11	17	34	42	48	56	68	85						
6,8		2	3	4	6	8	12	23	29	33	39	47	58	78				
10			2	3	4	5	8	16	20	23	27	32	40	53	80			
22						2	4	7	9	10	12	15	18	24	36	60		
33							2	5	6	7	8	10	12	16	24	40	60	80
47								3	4	5	6	7	8	11	16	28	42	56
68										3	4	5	6	8	12	20	39	39
100												3	4	5	8	13	19	27
150													3	3	5	9	13	18
220														2	4	6	9	12
330															2	4	6	8